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Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure

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U.S. Department of Commerce, Lewis L. Strauss, Secretary
National Bureau of Standards, A. V. Astin, Director

Maximum Permissible Body Burdens nd Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure

Recommendations of the
National Committee on Radiation Protection

National Bureau of Standards Handbook 69
Issued June 5, 1959
(Supersedes Handbook 52)

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Preface

The present Handbook and its predecessors stem from the Second International Congress of Radiology, held in Stockholm in 1928. At that time, under the auspices of the Congress, the International Commission on Radiological Protection (ICRP) was organized to deal initially with problems of X-ray protection and later with radioactivity protection. At that time "permissible" doses of X-rays were estimated primarily in terms of exposures which produced erythema, the amount of exposure which would produce a defined reddening of the skin. Obviously a critical problem in establishing criteria for radiation protection was one of developing useful standards and techniques of physical measurement. For this reason two of the organizations in this country with a major concern for X-ray protection, the American Roentgen Ray Society and the Radiology Society of North America, suggested that the National Bureau of Standards assume responsibility for organizing representative experts to deal with the problem. Accordingly, early in 1929, an Advisory Committee on X-ray and Radium Protection was organized to develop recommendations on the protection problem within the United States and to formulate United States points of view for presentation to the International Commission on Radiological Protection. The organization of the U.S. Advisory Committee included experts from both the medical and physical science fields.

As a result of the extensive developments immediately preceding and during World War II that added substantially to the importance of radiation protection problems, the Advisory Committee was reorganized in 1946 as the National Committee on Radiation Protection (and later, the National Committee on Radiation Protection and Measurements—NCRP). The revised Committee included representation from the various professional societies with an interest in the problem, government agencies with related interest and responsibilities, as well as individual experts. The continued sponsorship of the Committee by the National Bureau of

Standards was in accordance with its statutory responsibility to cooperate with other governmental agencies and with private organizations in the development of standard practices, incorporated in codes and specifications. In addition, the recommendations of the National Committee on Radiation Protection and Measurements have been published as handbooks by the National Bureau of Standards, again in accordance with its statutory authorizations.

The conclusions in the present handbooks are to be considered only as recommendations of a group of experts in the radiological protection field. They carry no legal implications demanding or requiring adoption. Inasmuch as the recommendations of the National Committee on Radiation Protection and Measurements impinge upon the areas of statutory responsibility of both the U.S. Public Health Service and the U.S. Atomic Energy Commission, it was considered important to determine that these agencies would not object to the publication of these recommendations by the National Bureau of Standards. Such assurances were obtained although these involve no commitment on the part of these agencies to adopt the recommendations of the National Committee on Radiation Protection and Measurements. Nor should the publication be construed as a recommendation by the National Bureau of Standards for adoption inasmuch as the important medical and biological factors involved in developing the recommendations are clearly outside of the Bureau's area of technical competence.

Since the publication in 1953 of the report of Subcommittee 2 of the National Committee on Radiation Protection on Permissible Internal Dose entitled "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water" (NBS Handbook 52) the study of the problem of internal irradiation has been continuous. The basic work for the preparation of this report has been handled to a major extent by Dr. K. Z. Morgan and by members of his staff at Oak Ridge. The same task has been carried out simultaneously for the corresponding committee of the International Commission on Radiological Protection of which Dr. Morgan is also Chairman.

Since 1953 new information relative to the problem of internal irradiation has been steadily increasing. Simultaneously there have been increasing demands for more information on radionuclides than was covered in the original edition of Handbook 52. In spite of the enormous amount of work which has been done by this subcommittee the

problem of developing maximum permissible concentrations of radionuclides is still rendered difficult because of the relatively limited direct experience with the action of the radiation from radionuclides on human tissues. The contents of this Handbook are based on what is believed to be the best information available and it is to be expected that as our knowledge increases the numerical quantities presented in this report will be in a state of continuous modification.

The recommendations of this Handbook take into consideration the NCRP statement entitled "Maximum Permissible Radiation Exposures to Man," published as an addendum to Handbook 59 on April 15, 1958.

As noted above this study was carried out jointly by the ICRP and the NCRP, and the complete report is more extensive than the material contained in this Handbook. It was felt that for the sake of producing a handbook suitable for daily use, some of the more extensive treatment of the problem could be omitted, since it would be made available in the complete ICRP report published by Pergamon Press. A Table of Contents of the parts of the ICRP report not contained herein is given on page 22. In addition the ICRP committee has prepared a detailed bibliography containing hundreds of references relative to the problem. Since the demand for this bibliography will be somewhat limited it will be made available as a separate publication by Pergamon Press.

The National Committee on Radiation Protection and Measurements is governed by representatives of 17 participating organizations, including the National Bureau of Standards. Eighteen subcommittees have been established, each charged with the responsibility of preparing recommendations in its particular field. The reports of the subcommittees are approved by the Main Committee before publication.

The following parent organizations and individuals comprise the Main Committee:

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E. C. Barnes, Amer. Indust. Hygiene Assoc.
C. M. Barnes, Amer. Veterinary Medical Assoc.
A. C. Blackman, Int. Assoc. of Govt. Labor Officials.
C. B. Braestrup, Radiol. Soc. of North Amer. and Subcommittee Chairman.
J. C. Bugher, Representative-at-large.
R. H. Chamberlain, Amer. College of Radiology.
W. D. Claus, U.S. Atomic Energy Commission.
C. L. Dunham, U.S. Atomic Energy Commission.
T. P. Eberhard, Amer. Radium Society and Subcommittee Chairman.

T. C. Evans, Amer. Roentgen Ray Society.
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W. B. Mann, Subcommittee Chairman.
W. A. McAdams, Atomic Indust. Forum and Subcommittee Chairman.
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K. Z. Morgan, Health Physics Society and Subcommittee Chairman.
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R. R. Newell, Amer. Roentgen Ray Society.
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E. H. Quimby, Amer. Radium Society and Subcommittee Chairman.
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E. G. Williams, Representative-at-large.
S. F. Williams, Capt., U.S. Navy.
H. O. Wyckoff, Subcommittee Chairman.

The following are the Subcommittees and their Chairmen:

Subcommittee 1.	Permissible Dose from External Sources. (Responsibility of the Executive Committee.)
Subcommittee 2.	Permissible Internal Dose, K. Z. Morgan.
Subcommittee 3.	X-rays up to Two Million Volts, T. P. Eberhard.
Subcommittee 4.	Heavy Particles (Neutrons, Protons, and Heavier), H. H. Rossi.
Subcommittee 5.	Electrons, Gamma Rays and X-rays Above Two Million Volts, H. W. Koch.
Subcommittee 6.	Handling of Radioactive Isotopes and Fission Products, J. W. Healy.
Subcommittee 7.	Monitoring Methods and Instruments, H. L. Andrews.
Subcommittee 8.	Waste Disposal and Decontamination. (This subcommittee has been inactivated.)
Subcommittee 9.	Protection Against Radiations from Ra, Co^{60} and Cs^{137} Encapsulated Sources, C. B. Braestrup.
Subcommittee 10.	Regulation of Radiation Exposure Dose, W. A. McAdams.
Subcommittee 11.	Incineration of Radioactive Waste, G. W. Morgan.
Subcommittee 12.	Electron Protection, L. S. Skaggs.
Subcommittee 13.	Safe Handling of Bodies Containing Radioactive Isotopes, E. H. Quimby.

Subcommittee 14. Permissible Exposure Doses Under Emergency Conditions, G. V. Leroy.
Subcommittee M–1. Standards and Measurement of Radioactivity for Radiological Use, W. B. Mann.
Subcommittee M–2. Standards and Measurement of Radiological Exposure Dose, H. O. Wyckoff.
Subcommittee M–3. Standards and Measurement of Absorbed Radiation Dose, H. O. Wyckoff.
Subcommittee M–4. Relative Biological Effectiveness, W. H. Langham.

The present Handbook was prepared by the Subcommittee on Permissible Internal Dose, with the following members:

K. Z. Morgan, Chairman	Oak Ridge National Laboratory
A. M. Brues	Argonne National Laboratory
P. Durbin	University of California
G. Failla	Columbia University
J. W. Healy	Hanford Works, Richland, Wash.
J. B. Hursh	University of Rochester
L. D. Marinelli	Argonne National Laboratory
W. S. Snyder	University of Tennessee
Shields Warren	New England Deaconness Hospital

In addition, many scientists of many countries have contributed, not only through their original research which is the basis of the report, but also by their generous aid in interpreting their results for use in this report. Finally, the technical work of collecting the data and interpreting it for conditions of occupational exposure as well as the writing of the text is largely the work of the Internal Dosimetry Section of the Oak Ridge National Laboratory headed by Dr. K. Z. Morgan. In particular, Mary Jane Cook has been responsible for the collection and presentation of the biological data, Mary Rose Ford has been responsible for the physical data used and for computation, James Muir and Janet Kohn have computed the tables for the gastrointestinal tract values and for the effective energies, respectively, and Dr. Walter S. Snyder has supervised the technical work and acted as secretary to the ICRP Committee II in preparing this report.

A. V. Astin, *Director.*

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Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure

1. Introduction

The National Committee on Radiation Protection (NCRP) has a subcommittee on permissible internal dose whose function is to provide recommended values of maximum permissible body burden, q, of radionuclides and maximum permissible concentration, MPC, of these nuclides in air and in water (or food). These values are provided only for the more important radionuclides, and they *are applicable primarily to occupational exposure.* This subcommittee has recognized that such compilations are of limited usefulness unless periodically revised to incorporate the best available information and extended to include the values required by new developments and uses. It has worked closely with the Internal Dose Committee of the International Commission on Radiological Protection (ICRP) in collecting these data and in making revisions of the earlier publications of the NCRP (1953)[1] and by the ICRP (1955).[2] In fact, the respective subcommittees on Internal Dose of the NCRP and ICRP have the same chairman.

To avoid unnecessary duplication of publication, this report of the NCRP is an abridgment of the ICRP Internal Radiation report. It includes a statement of basic philosophy, explanations and tables of "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure."

The portions of the ICRP report giving the procedures for calculation and the associated tables are not included

[1] Report of National Committee on Radiation Protection, National Bureau of Standards Handbook 52 (1953), Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

[2] Recommendations of the International Commission on Radiological Protection (1955) British Journal of Radiology, Supplement 6 (Meeting of the International Congress of Radiology held in Copenhagen, Denmark, 1953).

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in this report, and the reader should refer to the ICRP Internal Radiation report [5] for such information. A table of contents of those sections of the ICRP Internal Radiation report not included here is given at the end of this report.

In addition to revising and extending the earlier publications, the members of both committees hope that this publication will be a means of harmonizing and unifying the objectives and principles used by the NCRP and ICRP in arriving at their decisions.

The basic recommendations concerning permissible radiation exposure have been revised in recent years by the NCRP,[3] and similar revisions have been made by the ICRP.[4] An examination of the 1958 report of the ICRP reveals that the major changes of interest to Subcommittee 2 are the following:

(1) Instead of a weekly limit, a quarterly limit is recommended, thus giving greater flexibility for many operations.

(2) While the permissible quarterly rates for internal emitters are essentially comparable to former permissible rates, a limit on integrated dose is imposed in the case of exposure of the blood-forming organs and the gonads. The ICRP recommendations [4] also apply a limit on integrated dose to the lenses of the eyes, but the relevant data are so inadequate that the eyes are not considered as an organ of reference in either the 1953 or 1958 ICRP Internal Radiation reports.

(3) Recommendations are given for some nonoccupational groups and for the whole population.

A comparison of this publication with Handbook 52 (1953) will reveal that very extensive modifications have been required by new data and methods of estimating internal dose, and will indicate that the number of radionuclides listed in the earlier publication has been increased by about a factor of three. All biological and physical data used in the earlier publication have been reviewed and the permissible exposure values have been revised accordingly. Refinements in the calculations for the exposure of the gastrointestinal tract and for chains of radionuclides in the body have resulted in new values for many of the permissible limits. The "power function" model is discussed in the appendix of the ICRP Internal Radiation report [5] as an

[3] Report of National Committee on Radiation Protection, National Bureau of Standards Handbook 59. (Addendum, Jan. 8, 1957), Maximum permissible exposures to man. A preliminary statement of the National Committee on Radiation Protection and Measurement; (Addendum, Apr. 15, 1958), Maximum Permissible Radiation Exposures to Man. Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

[4] Recommendations of the International Commission on Radiological Protection, Main Commission Report, Sept. 9, 1958; Pergamon Press, London, England, 1959.

[5] Recommendations of the ICRP, Report of the Committee on Permissible Dose for Internal Radiation—1958 revision; to be published, Pergamon Press, London, England.

alternative method of estimating the body burden for certain long-lived radionuclides. The data in table 1 were calculated using the "exponential or compartment" model for retention and elimination, but the MPC and body burden values listed in the tables were selected after careful consideration by the subcommittee of the values obtained by the use of both models. While it is clearly impossible to be completely abreast of the literature in such a rapidly developing field, this publication represents the most important findings through 1957 as well as those in a few early publications of 1958.

All MPC values are given for a 40-hr workweek as well as for continuous exposure; i.e., a 168-hr week. Previous editions of the permissible internal-dose publications listed values based on continuous exposure, partly because these same values were sometimes used, with an appropriate factor, to apply to cases of continuous nonoccupational exposure and also because of variations in the length of the workweek.

The MPC values based on a 40-hr workweek are included because they are directly applicable to the standard working conditions existing in this country.

The MPC values listed for continuous occupational exposure are convenient in obtaining permissible levels for special groups. The appropriate factors to be applied in obtaining permissible levels for these groups are discussed in the ICRP report.[4,5] Because the continuous exposure MPC values listed neglect several important considerations, particularly differences between children and adults, it should be emphasized that, even when corrected by the above factors, these can only be regarded as interim values for nonoccupational exposure. It is hoped that the term *continuous occupational exposure values* will emphasize the provisional nature of their use for other purposes.

Although the data on which the MPC values are based are very incomplete and in some cases uncertain, they embody the latest and best research of hundreds of scientists; and it is believed that these MPC values are the best now available. They should serve as a guide to indicate whether the operational procedures used in practice are adequate to insure that the dose delivered by internally-deposited radioactive material does not exceed the pertinent permissible limit set by NCRP.

For many radionuclides the radiation-exposure period may last for many months or even a lifetime, although the intake may have occurred in a relatively short time. When

radioactive contaminants are deposited in the body, it is often difficult to make an accurate estimate of the total body burden or of its distribution in the body. In most cases, even when the fact is established that a person carries a large internal burden of a radionuclide, little can be done to hasten its elimination from the body. According to one theory, any dose of ionizing radiation, no matter how small, may produce some genetic or somatic damage; and thus, it is considered wise to avoid all unnecessary exposure to radionuclides. This has been pointed out, also, by several national and international [6] organizations. However, in the light of present knowledge, occupational exposure for the working life of an individual at the maximum permissible values recommended in this report is not expected to entail appreciable risk to the individual or to present a hazard more severe than those commonly accepted in other present day industries. The values given in this report are for occupational exposure and must be corrected by the application of appropriate factors for other uses; and, in all cases, the resultant tissue doses are intended to be in addition to those produced by the natural background and medical exposure.

2. Basic Standards of Maximum Permissible Radiation Exposure

The NCRP [3] has formulated the four following basic rules and recommendations concerning exposure to ionizing radiation:

Basic Rules

2.1. Accumulated Dose (Radiation Workers)

A. *External exposure to critical organs. Whole body, head and trunk, active blood-forming organs, eyes or gonads:* The Maximum Permissible Dose (MPD) to the most critical organs, accumulated at any age, shall not exceed 5 rems

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[6] Medical Research Council, The hazards to man of nuclear and allied radiation (1956), Cmd. 9780, Her Majesty's Stationery Office, London, England.
National Academy of Science, Publication 452, Pathologic effects of atomic radiation, NAS–NRC, Washington, D.C., (1956); The biological effects of atomic radiation, Summary Reports NAS–NRC, Washington, D.C., (1956); The biological effects of atomic radiation, A report to the public, NAS–NRC, Washington, D.C., (1956); The biological effect of atomic radiation—Gonadal dose from the medical use of X-rays, (preliminary report of Section III by J. S. Laughlin and I. Pullman) NAS–NRC, Washington, D.C., (March 1957).
Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, Gen. Assembly Off. Records, Thirteenth Session Supplement No. 17 (A/3838), New York, 1958. Annex G, Mammalian somatic effects pp. 153–171. Report of the World Health Organization, Effects of Radiation on Human Heredity, WHO, Palais des Nations, Geneva (1957).

multiplied by the number of years beyond age 18, and the dose in any 13 consecutive weeks shall not exceed 3 rems.

Thus the accumulated MPD=$(N-18)\times 5$ rems where N is the age in years and is greater than 18.

COMMENT: This applies to radiation of sufficient penetrating power to affect a significant fraction of the critical tissue. (This will be enlarged upon in the revision of H59.)

B. *External exposure to other organs. Skin of whole body:* MPD=10 (N–18) rems, and the dose in any 13 consecutive weeks shall not exceed 6 rems.

COMMENT: This rule applies to radiation of low penetrating power. See figure 2, H59.[3]

Hands and forearms, feet and ankles: MPD=75 rems/year, and the dose in any 13 consecutive weeks shall not exceed 25 rems.

C. *Internal exposures.* The permissible levels from internal emitters will be consistent as far as possible with the age-proration and dose principles above. Control of the internal dose will be achieved by limiting the body burden of radioisotopes. This will generally be accomplished by control of the average concentration of radioactive materials in the air, water, or food taken into the body. Since it would be impractical to set different MPC values for air, water, and food for radiation workers as a function of age, the MPC values are selected in such a manner that they conform to the above-stated limits when applied to the most restrictive case; viz., they are set to be applicable to radiation workers of age 18. Thus, the values are conservative and are applicable to radiation workers of any age (assuming there is no occupational exposure to radiation permitted at age less than 18.)

The maximum permissible average concentrations of radionuclides in air and water are determined from biological data whenever such data are available, or are calculated on the basis of an averaged annual dose of 15 rems for most individual organs of the body, 30 rems when the critical organ is the thyroid or skin, and 5 rems when the gonads or the whole body is the critical organ. For bone-seekers the maximum permissible limit is based on the distribution of the deposit, the RBE,[7] and a comparison of the energy release in the bone with the energy release delivered by a maximum permissible body burden of 0.1 μg Ra^{226} plus daughters.

[7] See discussion on p. 7.

2.2. Emergency Dose (Radiation Workers)

An accidental or emergency dose of 25 rems to the whole body or a major portion thereof, occurring only once in the lifetime of the person, need not be included in the determination of the radiation exposure status of that person (see p. 69, H59).[3]

2.3. Medical Dose (Radiation Workers)

Radiation exposures resulting from necessary medical and dental procedures need not be included in the determination of the radiation exposure status of the person concerned.

2.4. Dose to Persons In the Neighborhood of Controlled Areas

The radiation or radioactive material outside a controlled area, attributable to normal operations within the controlled area, shall be such that it is improbable that any individual will receive a dose of more than 0.5 rem in any 1 year from external radiation.

The maximum permissible average body burden of radionuclides in persons outside of the controlled area and attributable to the operations within the controlled area shall not exceed one-tenth of that for radiation workers.[8] This will generally entail control of the average concentrations in air or water at the point of intake, or of the rate of intake to the body in foodstuffs, to levels not exceeding one-tenth of the maximum permissible concentrations allowed in air, water, and foodstuffs for continuous occupational exposure. The body burden and concentrations of radionuclides may be averaged over periods up to 1 year.

The maximum permissible dose and the maximum permissible concentrations of radionuclides as recommended above are primarily for the purpose of keeping the average dose to the whole population as low as reasonably possible, and not because of the likelihood of specific injury to the individual.

2.5. Discussion

A minor difference will be noted between the above recommendation and those of the ICRP. The NCRP allows the skin only 6 rems in any 13-week period as compared with 8 rems allowed by the ICRP. The difference is unimportant, and the NCRP would probably have adopted the value of 8 rems had not its recommendations been published nearly a year earlier. The ICRP also uses a value of 8 rems in any 13 weeks as an upper limit for the dose to the

[8] Based on continuous occupational exposure for a 168-hr week.

thyroid; the NCRP has not specifically stated a 13-week limit for the thyroid. Any calculations in this report involving the skin or thyroid are based on the ICRP value of 8 rems in any 13 consecutive weeks.

The decision of the ICRP [9] (1956) to set the average external occupational exposure at 5 rems per year (corresponding to 0.1 rem per week) is not applied to internal dose calculations except in the cases of radionuclides that are distributed rather uniformly throughout the body or are concentrated in the gonads. The purpose of limiting the average weekly total body dose (0.1 rem) to 1/3 of the former maximum weekly dose (0.3 rem) was to lessen the possible incidence of certain types of somatic damage; e.g., radiation-induced leukemia and shortening of life span, which are considered to result primarily from total body exposure. Obviously, the reduction in the gonad dose was intended to lower the incidence of deleterious genetic mutations that could give rise to effects appearing in future generations.

Inasmuch as the restriction of integrated dose applies primarily to the total body and gonad dose, there is no basic change in the permissible RBE dose rate when individual organs [10] such as liver, spleen, bone, gastrointestinal (GI) tract, and kidney are the critical body organs for reasons given in ICRP report paragraph (14).[4] It should be noted that the limits recommended here are maximal. In practice, the average occupationally-exposed individual would receive a much lower dose.

Because the direct determination of the body burden or of the dose to an organ or to the total body is generally difficult, and because in most cases measures to decrease the body burden are rather ineffective and difficult to apply, the only practical procedure for general protection of occupational workers is to limit the concentration of the various radionuclides in the water, food, or air available for consumption. It is recommended, therefore, that:

(a) If there is no occupational external exposure, the concentration of a radionuclide or a mixture of radionuclides

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[9] Report on amendments to the recommendations of the International Commission on Radiological Protection (ICRP), Radiology **70**, 261–262 (1958).
Report on amendments during 1956 to the recommendations of the International Commission on Radiological Protection, Acta Radiologica **48**, 493–495 (1957); or British J. Radiology **31**, 93–94 (1958).
Meeting of the Main Commission and Committee Chairmen of the International Commission on Radiological Protection, held in New York City, March 3–5, 1958.

[10] All references for scientific data cited in this report are given in abbreviated form; they are listed in full in Bibliography for Biological Data, Pergamon Press, London, England. See Col-1, Fk-6, Fr-8, Ja-7, Ja-8, Swi-1, Swi-2, and Zr-1.

in air and in water which might be consumed by plant personnel during a 40-hour week be kept at levels not exceeding the appropriate MPC values given in this report. If there is occupational external exposure, the MPC values must be lowered to bring the total RBE doses within the limits prescribed by the basic rules. Thus, if D rem is the quarterly dose permitted to an organ by the basic rules and if external radiation delivers a dose of E rem per quarter, then the MPC based on this organ must be reduced by the factor (D–E)/D. The calculation of an acceptable level for the case of a mixture of radionuclides is discussed in section IV–8 of the ICRP Internal Radiation report.[5]

(b) Alternatively, over a period of 13 weeks, the concentrations of the various radionuclides present in air or in water may be allowed to vary, provided the total intake during any 13-week period does not exceed the total intake permitted by exposure at the constant levels indicated in subsection (a) above. (It should be realized that while this method is in accordance with the basic recommendations its use is cumbersome, expensive, and generally unreliable, because it requires accurate and continuous monitoring of work areas and the keeping of detailed exposure histories for each individual. Its use is, therefore, only justified in exceptional cases.)

The safest and simplest procedure to use in keeping within the basic limits given above is to maintain the level of contamination of the air, water, or food consumed by plant personnel in the controlled area at or below the indicated MPC values. These values are given for an exposure period of 40 hours per week and 168 hours per week. If a person's work assignments are such that he spends only 8 hours each week in the exposure area, the applicable MPC values are 5 times those listed for a 40-hour week in table 1. However, this requires considerable care to determine that he is effectively unexposed during the remainder of his working week. If he spends 48 hours each week in the exposure area, the applicable MPC values are five-sixths of those listed for a 40-hour work week in table 1.

Although the formula $5(N-18)$ permits an average yearly dose to the total body and the gonads of only 5 rems, the rules of the NCRP permit up to 3 rems during any interval (e.g., 1 minute, 1 day, 1 week, etc.) provided that not more than 3 rems are received in any 13 consecutive weeks. Thus an older person may receive up to 12 rems external exposure in a single year provided his dose does not exceed the limits prescribed by the formula $5(N-18)$. Although this

flexibility is allowed in principle for internal exposures, in practice it is risky and usually impractical to increase the MPC values much beyond those determined for operation over an extended period. The permissible levels do, however, take into account the exposure period, and if the occupational exposures last for only 1 hour per week, the MPC values for a 40-hour week may be increased by a factor of 40. As an example, take the case of a specific situation where sufficient monitoring is available (i.e., external monitoring meters, body fluid analyses, air surveys, etc.) and where no exposure has been received for the prior 13-week period. If the restriction implied by the formula $5(N-18)$ is not exceeded, the person may work for 1 hour where the concentration in air of an isotope with the total body as the critical organ is roughly 1200 times the Maximum Permissible Concentration in air $(MPC)_a$ for a 40-hour week.[11]

In such a case no further exposure shall be permitted in the succeeding 13 weeks. This practice should be discouraged because of delays and inaccuracies in methods of estimating the body burden and dose to the organ from such an internally deposited radioactive material. However if such exposures to contaminated air are unavoidable, the dose may be reduced materially if appropriate and properly fitting respirators are worn.

While these revised MPC and body burden values presented here take into account many refinements previously neglected, there remain many serious uncertainties in the basic biological data on which the calculations are based and thus it is necessary again, as in the earlier handbooks, to urge that all exposures be kept to the minimum practically obtainable. While the data used for these estimates are believed to be the most reliable presently available, their use generally involves an extrapolation in time or in dosage level and they cannot be considered as definitive.

The Internal Dose Committees of the NCRP and of the ICRP are collecting available data on the long-range effects of low-level exposure to the population at large. These data include information on somatic damage to the exposed individual, genetic damage to his children, and ecological damage. It is hoped that this new table of values will be available for inclusion in the next revision of this publication.

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[11] $40\times13\times12/5\cong1200$, where 12 is the maximum, and 5 is the average yearly dose.

3. Maximum Permissible Values for Occupational Exposure to Radiation

3.1. Assumptions and Restrictions Applying to Maximum Permissible Exposure Values in Table 1

The values of q and MPC for an individual will depend upon many factors such as his age, physical condition, eating habits, and hygienic standards. They will depend also upon the physical and chemical properties of the radioactive material and the method of intake—by ingestion, by inhalation, through wounds, or by absorption through the skin. The paucity of data concerning the effect of most of these factors does not warrant detailed treatment. To keep the required work and the magnitude of this revision within reasonable limits and yet to meet the major needs of scientific and industrial users of radionuclides it has been necessary to limit severely the number of factors considered. Therefore, MPC values are listed only for relatively insoluble and for the more common soluble compounds, and these compounds are specified only by the extent of solubility rather than by specific chemical structure. The only methods of intake considered are ingestion and inhalation, except in a few cases—where immersion presents the greatest hazard criterion. All calculations are based on a "standard man" and thus do not provide for individual variations. The standard man is specified in tables VI through XI of the ICRP Internal Radiation report [5] and is a somewhat modified version of the standard man defined at the Chalk River Conference [12] (September 1949). This standard man is designed to represent a typical or average adult who is exposed occupationally.

Ideally, maximum permissible body burden, q, and maximum permissible concentration, MPC, should be based on studies of humans who have been exposed to and who have ingested a particular radionuclide under the working conditions and over an extended period of time approximating those which are typical of the average occupational exposure. However, human data are very scarce and only in the case of radium does one have an accumulation of human experience for as long as 50 years, which is the minimum for selecting values for chronic exposure to man. Studies using total and partial body counters have been made recently to

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[12] Chalk River Conference on Permissible Dose. A conference of representatives from the United Kingdom, Canada, and the United States, meeting in Chalk River, Canada, September 29 and 30, 1949. RM-10 (1950).

determine the uptake, distribution and elimination of trace quantities of some radionuclides in the human body. In a few cases, certain radionuclides have been administered to humans therapeutically, and in some cases, accidents have occurred in which radionuclides have been taken into the body. The data from these cases of human exposure have been studied carefully, and, where possible, such data are substituted in this report for earlier data based on animal experiments. For the majority of radionuclides, human data are lacking, and in such cases data from animal experiments must be extrapolated to man. Sometimes even animal data are not available and estimates are made from comparison with elements having similar chemical behavior. Recent studies of trace and minor stable element distribution in the human body [13] have been particularly helpful in these revisions. It is assumed that the normal stable element distribution in the various body organs is typical of the distribution that would result from human exposure to radionuclides of these same elements and that the chemical form is similar. Likewise, a study of the metabolic balance between the trace and minor elements in the food, water, urine, and feces of man has yielded direct data for the MPC of radionuclides of these elements. Because of the many assumptions and approximations made in applying much of the data in this publication, *it is concluded that detailed refinements in the calculations generally are unwarranted.*

In table 1 are the recommended values of maximum permissible total body burden, q, and maximum permissible concentration in air, $(MPC)_a$, and in water, $(MPC)_w$, for about 240 radionuclides. The daily intake of water used in calculating $(MPC)_w$ includes the water content of food and thus consideration of the intake of a radionuclide in food is necessary only in case it concentrates in the food during processing or enters the food from other sources. In such cases the $(MPC)_w$ values of table 1 converted to microcuries per gram are applicable when corrected for daily intake, i.e., to take account of the total intake of radionuclides in the complete diet. This publication includes values for all the radionuclides listed in the previous publications of NCRP [1] (1953) and of ICRP [2] (1955) together with others for which a need has arisen and for which the necessary biological data are available. With few exceptions (e.g., certain daughter radionuclides and isomeric states) radionuclides with radio-

[13] See the section of the ICRP Internal Radiation report [5] titled "Bibliography for Biological Data," Ti-1 through Ti-7, Tie-1, Sti-1 through Sti-4, Kc-1, Kc-2, Rm-2, Kh-4, Gro-1, Led-1, Bg-1 through Bg-6.

active half-lives shorter than 1 hour are not considered in table 1. The following are the principal assumptions and factors which were used in the calculations.

(a) In all cases the values are listed both for soluble and for insoluble compounds (an exception is the case of some of the inert gases for which values are given only for the immersion of a person in the inert gas). The lowest values of $(MPC)_a$ and $(MPC)_w$ are given in boldface type both for the soluble and insoluble forms of the isotope. The organs on which these values are based are termed the critical organs and are also boldface in table 1.

(b) In all cases the values are computed for occupational exposure at the rate of 40 hours per week, 50 weeks per year for a continuous work period of 50 years, as well as for 50 years of continuous exposure, i.e., 168 hours per week.

(c) In all cases the calculated dose rate which determines the MPC takes into account the actual amounts of the radionuclide in the body or critical organ rather than assuming a state of equilibrium. The MPC values based on a critical organ are set by the requirement that the dose rate (rem per week) after 50 years of occupational exposure shall not exceed the values specified in section 2. During a 50-year exposure period, equilibrium is reached for the vast majority of the radionuclides because the effective half-life is short compared to this work period (i.e., the term $e^{-0.693t/T}$ in equations 7 and 8 of the ICRP Internal Radiation report [5] is approximately zero for $t=50\times365$ days). Exceptions to this rule are listed in table 2. Column 5 of table 2 gives the effective half-life, and column 6 gives the percent of equilibrium the body burden attains as a result of constant exposure to the MPC over a period of occupational exposure lasting 50 years. Most of the exceptions are in the 5-*f* type rare earth group of elements which are assigned a biological half-life of 200 years. The extreme case is represented by 10 of these radionuclides which reach only 16 percent of equilibrium in the body in 50 years of occupational exposure.

(d) In the case of a radionuclide which decays to form radioactive daughters, the calculation assumes that only the parent radionuclide enters the body, but the estimated dose rate includes all the energy released by the daughter elements formed in the body. There are two exceptional cases, Rn^{220} and Rn^{222}, where a state of equilibrium typical of that attained in ordinary air is assumed. These cases [5] are discussed in detail in the ICRP Internal Radiation report. In all other cases it is assumed that only the parent element enters the body. Because the various daughter elements generally have different effective half-lives the percent of equilibrium at-

tained is generally not the same for all elements of a chain. Also, the effective energies, are not the same for different members of the chain so that the dose rate after 50 years' exposure will generally not be the same percentage of the dose rate resulting from an equilibrium body burden as the figure shown in table 2. Thus for radionuclides which decay to form radioactive daughters these percentages give only a rough indication of the percent of equilibrium dose rate attained at the end of 50 years.

(e) The assumptions and formulas are presented in terms of a compartment model, i.e., each organ is assigned a biological half-life and the radionuclide that accumulates in the organ is considered to be eliminated at a constant rate. In general, this is a drastic oversimplification of the situation since the organ retention usually requires several exponentials, or perhaps a power function, for its mathematical representation. Unfortunately, the biological information available generally does not yield detailed information on organ retention, particularly for the conditions and periods of exposure of interest here. In selecting MPC and body burden values, the subcommittee has considered both multiple exponential and power function models for retention when such information is available and the values finally selected are in some cases chosen between those calculated by these models. In view of the large measure of uncertainty in many of these cases, and in the interest of uniformity and economy of presentation the biological data in the tables are given in terms of a single compartment model for each organ considered with a biological half-life for each. The values of these are selected to produce in 50 years of exposure at a relatively constant level, the retention indicated by the more detailed model, and thus may not represent accurately the situation for short-term exposure. (A discussion of the power function model and a table of the necessary parameters for its use are given in the appendix of the ICRP Internal Radiation report.[5])

(f) If occupational exposure continues beyond 50 years, the dose rate will continue to rise in the case of the radionuclides listed in table 2 because they are not in a state of equilibrium under the assumed conditions of constant exposure level at the MPC, but for the radionuclides not listed in table 2 the maximum permissible dose rate would not be exceeded. However, since the period of occupational exposure probably will not greatly exceed 50 years, and since the maximum permissible body burden, q, would be reached only after 50 years of occupational exposure at the MPC

values given in table 1, the average RBE dose rate over the working life of the individual will be well below the maximum permissible RBE dose rate even for the isotopes in table 2. While noteworthy, this observation does not alter the fact that the terminal RBE dose rates would be in violation of the criteria adopted in section 2, although the integrated RBE dose undoubtedly would be considerably less than that permitted for many radionuclides not listed in table 2. In the previous publications,[1] [2] the calculations were based on a 70-year exposure. Although this change to an exposure period of 50 years has had very little effect on the MPC values (i.e., a maximum increase of 27 percent in the MPC values for some of the radionuclides in table 2), it is believed that this change should be made in the calculations because for most workers in controlled areas the working period extends from age 18 to age 65 or less.

(g) The average breathing rate 10^4 l per 8-hour work day; this is one-half the air breathed in 24 hours.

(h) The average rate of water consumption is 1100 ml per 8-hour work day; this is one-half the water consumed in 24 hours.

(i) The dose from inert gases with radiation of sufficient energy to penetrate the minimal epidermal layer ($7 mg/cm^2$) results from external exposure to the surrounding cloud of radioactive gas rather than from the amount of gas in the body.

(j) With one exception, chemical toxicity is not considered in estimating the body burden or MPC values. However, in the case of uranium, the chemical toxicity has been considered and is the limiting criterion for the longer-lived nuclides of uranium.

3.2. Units of Ionizing Radiation Used in Table 1

In table 1 the units are the microcurie (μc) and microcurie per cubic centimeter ($\mu c/cc$) for maximum permissible quantities of the various radionuclides in the total body, q, and for the maximum permissible concentrations in air, $(MPC)_a$, and in water, $(MPC)_w$. One curie is a quantity of a radioactive nuclide in which the number of disintegrations per second is 3.700×10^{10}; the microcurie then, is 1 millionth of this amount. In accordance with long established usage in internal dose calculations, however, a curie of recently extracted uranium is considered to correspond to the sum of 3.7×10^{10} dis/sec from U^{238}, 3.7×10^{10} dis/sec from U^{234}, and 9×10^{8} dis/sec from U^{235}. Also, a curie of recently extracted thorium is considered to correspond to the sum of 3.7×10^{10}

dis/sec from Th^{232} and 3.7×10^{10} dis/sec from Th^{228}. The rem is the unit of RBE dose of ionizing radiation in tissue. When a dose is expressed in rems it is superfluous to call it RBE dose. Therefore, the unqualified term "dose" is used in such cases. The rem corresponds to the dose in tissue which results in a biological effect equivalent to that produced per rad of X-radiation (of about 200 kv) having a linear energy transfer, LET, to water of 3.5 kev per micron, i.e., rem=RBE×rad. The rad corresponds to an energy absorption of ionizing radiation of 100 ergs per gram in any medium. In this case the energy absorption is in tissue. The relative biological effectiveness, RBE, in this report is taken as one for β, γ, X-radiation, and conversion electrons (for low energy β emitters, i.e., $E_m \leq 0.03$ Mev, the RBE= 1.7), 10 for α-particles, and 20 for recoil nuclei. The reader is referred to the Handbook by the International Commission on Radiological Units for detailed information on units.[14]

3.3. Critical Body Organ

The values of body burden, q, in column 3 of table 1 are based on that amount of the radionuclide which is deposited in the total body and produces the maximum permissible RBE dose rate to the body organ listed in column 2. The concentration values in water (columns 4 and 6) and in air (columns 5 and 7) are in turn based on the intake by the standard man who accumulates this body burden as a consequence of occupational exposure for a period of 50 years. In most cases significantly different values of body burden result when effects on different organs are considered. The critical organ is determined by the following criteria: (1) the organ that accumulates the greatest concentration of the radioactive material; (2) the essentialness or indispensability of the organ to the well-being of the entire body; (3) the organ damaged by the entry of the radionuclide into the body; and (4) the radiosensitivity of the organ, e.g., the organ damaged by the lowest dose. Theoretically all of these considerations are taken into account through the use of the RBE factors, the basic standards, and the methods of calculation. Actually, except for a few radionuclides, case (1) above is the determining factor in choosing the critical body organ. For this revision, each radionuclide was studied individually. For some radionuclides as many as 12 reasonable choices of a critical organ were made with the corresponding permissible body burden and concentra-

[14] Report of the International Commission on Radiological Units and Measurements (ICRU) 1956, National Bureau of Standards Handbook 62 (1957). Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

tion values calculated for each organ, and these are listed in table 1. In the present state of our knowledge the organ giving the lowest MPC value seems the most likely choice as the critical organ; therefore such organs and such minimal values are printed in boldface type. For each isotope the MPC values are listed first for soluble materials and then for insoluble materials. The values for soluble materials are ranked with increasing magnitude of $(MPC)_w$ so that the first line in this group designates the critical organ determined primarily on the basis of having the lowest $(MPC)_w$. The values for insoluble materials are ranked according to the magnitude of $(MPC)_a$. The rankings based on $(MPC)_a$ and on $(MPC)_w$ may differ in some cases so the smallest MPC in each group is in boldface type to indicate it as a maximum permissible occupational exposure level for plant operation under the stated conditions. The MPC values for other organs (termed organs of reference in table 1) are given primarily as an aid in estimating MPC values for mixtures of radionuclides and thus by themselves are not permissible levels.

The total body is listed as an organ of reference for all nuclides except a few of the inert gases. Values for the total body are included primarily as an aid in computing MPC values for mixtures, and as a check on the oversimplified model used. As mentioned in (e) above, this one-compartment model is selected to represent the long-term retention in the critical organ and may not represent adequately the situation in other organs. For example, radium and strontium are long-term bone-seekers, but during the first day or two following ingestion appreciable amounts are present in the plasma and soft tissues. This amount may be negligible so far as the 50-year accumulation in the bone is concerned, but a check is necessary to determine that the amount present in the plasma and soft tissues does not increase the body burden in excess of the permissible limit. When present in a mixture, perhaps with other isotopes that concentrate primarily in the soft tissues, the dose delivered by this component of the total quantity should not be neglected. The MPC based on the retention of radionuclides in the total body also supplies a ready means of estimating the integrated dose, i.e., the dose to the body as a whole.

While the basic rules do not directly limit the integrated dose except in the case of whole body irradiation, knowledge of it is of considerable interest. Because the total body limit for constant-level exposure is based on an average of 5 rems per year (0.1 rem per week), the total body is sometimes the

critical organ. Because the GI tract often receives a greater absorbed dose than any other body organ, and is frequently the critical organ for exposure to mixed fission products, it is, with few exceptions, included as an organ of reference for the soluble form of the radionuclides in table 1. MPC values are given also for the insoluble form of the radionuclides in which case the critical organs are the lungs or the GI tract.

3.4. Maximum Permissible Concentration of Unidentified Radionuclides (MPCU)

The identity of the radioactive contaminants in air, water, and food must be established before appropriate MPC values can be applied either for occupational exposure or for exposure to population outside of controlled areas. In many cases there is no question regarding the identity of a radionuclide because the operation involves only one radionuclide. Sometimes, however, preliminary surveys of radioactive contamination leave considerable uncertainty as to which radionuclides are the major contributors. When a laboratory is using a number of radionuclides, such as mixed fission products, an air sample may furnish only a few clues as to the identity of the radionuclide. By using the simplest of equipment and techniques, the level of air contamination may be established in a matter of minutes, but hours or even days may be required to conduct the radiochemical analyses necessary to identify the particular radionuclides that are present in the air. Fortunately, in such cases it is usually not necessary to go through a tedious, time-consuming and expensive radiochemical analysis. If it is known that certain of the more dangerous radionuclides could not be present (i.e., the concentration of the more dangerous radionuclides is small compared with the MPC values in table 1) the operation may be continued safely regardless of the radionuclide or mixture of radionuclides, provided the concentration does not exceed the values for MPC of unidentified radionuclides (MPCU) as listed in table 3 for water or in table 4 for air. These MPCU values are applicable to continuous occupational exposure (168 hours per week) and should be multiplied by 1/10 if they are to be applied as interim values outside, and in the neighborhood of, the controlled exposure area. It should be pointed out that the use of MPCU values may save an immense amount of effort and expense if they are applied properly to avoid unnecessary radionuclide analyses in areas where the air, water, and food contamination is usually less than the appro-

priate MPCU values. On the other hand, they can impose a needless penalty if improperly applied. For example, if initial measurements indicate a negligible amount of Ra^{226} and Ra^{228} in the drinking water of a small community near an atomic energy laboratory, and if it is determined by daily gross $\beta+\gamma$ sample counting that the activity does not exceed the $(MPCU)_w$ value, $(1/10\times1\times10^{-6}\ \mu c/cc=1\times10^{-7}\ \mu c/cc)$ it would seem foolish to carry out a daily radiochemical analysis of this water. If, on the other hand, the level ranged between 10^{-5} and 2×10^{-5} $\mu c/cc$, it would be unwise to shut down the plant or to instigate an expensive modification of the operation without first identifying the radionuclides for it might be that the contamination in the water is from Na^{24} and P^{32}. In this case the appropriate $(MPC)_w$ value for application in the neighborhood of the plant is $1/10\times2\times10^{-3}=2\times10^{-4}$ and $1/10\times2\times10^{-4}=2\times10^{-5}$, respectively (see table 1).

3.5. Maximum Permissible Concentration of Known Mixtures of Radionuclides

Suppose a person is exposed to concentrations ρ_{aA}, ρ_{aB}, . . . ρ_{wA}, ρ_{wB} . . . μc per cc of isotopes A, B, . . . in air and in water, respectively, and also to external sources of gamma and neutron radiations. Assume further that the external sources give doses R^x_γ, R^x_n to a given organ X for gamma and neutron radiation, respectively. If L^x rem is the average weekly dose permitted to organ X by the basic rules, then the total dose to organ X is

$$\left[\frac{\rho_{aA}}{(MPC)^x_{aA}}+\frac{\rho_{aB}}{(MPC)^x_{aB}}+\cdots+\frac{\rho_{wA}}{(MPC)^x_{wA}}+\frac{\rho_{wB}}{(MPC)^x_{wB}}+\cdots\right]L^x+R^x_\gamma+R^x_n. \quad (1)^{15}$$

This does not exceed L^x provided

$$\frac{\rho_{aA}}{(MPC)^x_{aA}}+\frac{\rho_{aB}}{(MPC)^x_{aB}}+\cdots+\frac{\rho_{wA}}{(MPC)^x_{wA}}+\frac{\rho_{wB}}{(MPC)^x_{wB}}+\cdots\frac{R^x_\gamma}{L^x}+\frac{R^x_n}{L^x}\leq1 \quad (2)^{15}$$

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[15] See equations 22 to 24 in ICRP Internal Radiation report.

and this provides a criterion for assessing whether or not the exposure is in excess of that permitted by the basic rules. If organ X is not listed as an organ of reference in table 1, and if an independent estimate of the corresponding MPC values is not available, the MPC based on total body may be used with the correction factor $L^x/0.1$, i.e., $L^x(\mathrm{MPC})_a^{TB}/0.1$ and $L^x(\mathrm{MPC})_w^{TB}/0.1$ may be substituted for $(\mathrm{MPC})_a^x$ and $(\mathrm{MPC})_w^x$ in such cases. In general it will be necessary to calculate the dose for all the organs for which the dose may reasonably be considered to be in excess of the prescribed limits. Often this may include the total body even though no one of the radionuclides irradiates a major portion of the body. Assuming that a major portion of the body is being irradiated at somewhat comparable rates, the calculation is essentially as before except that the MPC values based on total body are to be used. Thus, the criterion is

$$\frac{\rho_{aA}}{(\mathrm{MPC})_{aA}^{TB}}+\frac{\rho_{aB}}{(\mathrm{MPC})_{aB}^{TB}}+\cdots+\frac{\rho_{wA}}{(\mathrm{MPC})_{wA}^{TB}}+\frac{\rho_{wB}}{(\mathrm{MPC})_{wB}^{TB}}+\cdots+\frac{R_\gamma^{TB}}{0.1}\frac{R_n^{TB}}{0.1}\leq 1. \quad (3)^{15}$$

In effect this limits the average dose rate over the body to 0.1 rem per week. There may be some organs in which the dose rate exceeds 0.1 rem per week, but this is considered permissible so long as such organs do not constitute a major portion of the body. Of course, the criteria for these organs must also be considered, and the application of equation (2) will prevent any particular organ from exceeding the permissible limit set for that organ. However, it would seem too conservative and contrary to the intent of the basic rules to limit the dose to any portion of the body to a maximum rate of 0.1 rem per week merely because the entire body is receiving some dose, though it may be very small in most of the body and only be at the rate of 0.1 rem per week in a small portion. The values of $(\mathrm{MPC})^{TB}$ as given in table 1 and as applied in equation (3) were derived on the assumption that the total body dose of interest in this case is the gram-rem dose or the total weighted energy delivered to the total body.

(See Section IV–8 of ICRP Internal Radiation report.[5])

The application of these criteria may be illustrated by the following example: Suppose the mixture consists of Sr^{90}, Pu^{239}, Na^{24}, and that an external gamma source is also present, and that the measured intensities are those indicated

in table 5. The concentrations have been chosen to illustrate the case of a mixture which is below the permissible limit for one of the criteria (bone), but is barely in excess of the limit determined by another of the criteria (total body).

Criterion (2) applied to bone gives

$$\frac{\rho_{aA}}{(\mathrm{MPC})^{x}_{aA}}+\frac{\rho_{wA}}{(\mathrm{MPC})^{x}_{wA}}+\frac{\rho_{aB}}{(\mathrm{MPC})^{x}_{aB}}+\frac{\rho_{wB}}{(\mathrm{MPC})^{x}_{wB}}$$

$$+\frac{0.1}{0.56}\left[\frac{\rho_{aC}}{(\mathrm{MPC})^{TB}_{aC}}+\frac{\rho_{wC}}{(\mathrm{MPC})^{TB}_{wC}}\right]+\frac{R^{x}_{\gamma}}{L^{x}}=0.06+0.038$$

$$+0.2+0.13+\frac{0.1}{0.56}(0.1+0.2)+\frac{0.065}{0.56}=0.60<1.$$

Thus, the average dose rate to the bone is about $0.60\times 0.56=0.34$ effective rem per week and is therefore within the limits set for bone.

Criterion (3) for total body gives

$$\frac{\rho_{aA}}{(\mathrm{MPC})^{TB}_{aA}}+\frac{\rho_{wA}}{(\mathrm{MPC})^{TB}_{wA}}+\frac{\rho_{aB}}{(\mathrm{MPC})^{TB}_{aB}}+\frac{\rho_{wB}}{(\mathrm{MPC})^{TB}_{wB}}$$

$$+\frac{\rho_{aC}}{(\mathrm{MPC})^{TB}_{aC}}+\frac{\rho_{wC}}{(\mathrm{MPC})^{TB}_{wC}}+\frac{R^{TB}_{\gamma}}{L^{TB}}=0.02+0.015+0.04$$

$$+0.013+0.1+0.2+0.65=1.038$$

and thus, the calculation indicates that the mixture is slightly, though not significantly, in excess of the permissible limit for total body.

If the gamma source is removed, the dose rate to the bone becomes $0.48\times 0.56=0.27$ rem per week while the dose rate to the total body is $0.39\times 0.1=0.039$ rem per week. These dose rates are 48 percent and 39 percent of the corresponding limits, and thus, the bone is now the critical organ. In this situation any or all of the concentrations could be increased by as much as a factor of 2 without exceeding the permissible limits.

3.6. Modifications Required for Other Applications

The MPC values listed in table 1 are primarily intended for occupational exposure. Nevertheless, they are frequently used for a variety of other purposes. In most cases the conditions of exposure will not strictly conform to the conditions assumed for the calculation of these values. Thus, great care

and judgment should be used to insure that the departure from the conditions of occupational exposure assumed in table 1 are not so great as to completely invalidate the use of these values. In order to guard against the all-too frequent misuse of these values, some of the more common pitfalls that may often lead to large discrepancies will be mentioned.

A 50-year exposure period is assumed in deriving the MPC values in table 1, and the exposure level is assumed to be constant. Thus a transient situation (e.g., fallout shortly after a nuclear detonation or a major reactor accident where the level of activity is rapidly decreasing, and even the relative abundance of different radionuclides will be changing) presents a hazard widely different from the constant level 50-year occupational exposure which is assumed. The measure of difference is here so large that to attempt to correct it amounts to a new calculation.

The $(MPC)_w$ values listed in table 1 may, with caution, be applied to foods but to use the $(MPC)_w$ for the 168-hour week without correction for actual intake amounts to assuming that 2200 grams [16] of the individual's food, (i.e., substantially all his food) is contaminated at this level and that this situation will persist for 50 years, or until equilibrium is reached in the body. Obviously, a correction factor to take account of the food intake is needed, but to simply use the ratio of 2200 grams to the grams of intake of a particular food (e.g., butter) as correction factor amounts to assuming no other foods or beverages are contaminated. Again all the factors in the total situation must be considered and great judgment must be used in making such corrections.

Frequently the MPC values are used to obtain estimates of dose from large single intakes of a radionuclide. In many cases this is warranted but there may well be many cases where the distribution in the body following an acute exposure to the nuclide is markedly different from the distribution pattern reached following continuous, low-level exposure. For example, many nuclides concentrate in bone with a long biological half-life which leads to a large bone burden of the nuclide after many years of exposure. Then the bone is the critical organ although the fraction of the daily intake reaching the bone may be much smaller than that passing through the GI tract. For an acute single dose the GI tract may be the critical organ.

Many other factors may have a large effect in determining the proper value for a maximum permissible limit. The

[16] The average daily intake of water for the standard man.

relative abundance or scarcity in the diet of other nonradioactive nuclides with similar chemical properties, the wide range of physiological differences as well as differences in habits, age and sex, and the chemical form of the radionuclide or the size of the particle to which it is attached, may account for large changes in the value of the MPC in some cases. Many of these factors as well as others are being carefully studied at the present time, and we may expect that our knowledge of their influence on the permissible levels will be more precise. In the present state of our knowledge, the modification or adaptation of the values listed in table 1 for application to other situations than those specified by the exposure categories of the basic rules requires the careful consideration and mature judgment of competent experts in this field.

4. Additional Contents of ICRP Internal Radiation Report [5]

IV. Calculation of Maximum Permissible Exposure Values

1. Basis for Estimating Maximum Permissible Exposure Values.
2. Body Burden Based on Comparison with Radium.
3. Body Burden Based on a Permissible RBE Dose Rate to the Critical Organ.
4. Concentrations in Air and Water—Based on Exponential Model—Critical Organs Other than Gastrointestinal Tract.
5. Concentrations in Air and Water Based on RBE Dose Delivered to Various Segments of the GI Tract.
6. Maximum Permissible Concentration of Radionuclides of Noble Gases and Other Relatively Inert Gases.
7. Maximum Permissible Concentration of Unidentified Radionuclides. (Included in this report.)
8. Maximum Permissible Concentration of Known Mixtures of Radionuclides. (Included in this report.)
9. Modifications Required for Other Applications. (Included in this report.)

V. Factors Needed for Calculation of MPC Equations

1. Effective Energy.
2. Standard Man Data.
3. Other Biological and Physical Related Terms.

Appendix. Concentrations in Air and in Water Based on a Power Function Model

Tables of ICRP Internal Radiation Report

Tables I to IV	(1 to 5. Included in this report)
Table V	Effective Energies
Table V A	Effective Energies for Chains
Table VI	Element Distribution in Total Body of the Standard Man
Table VII	Elements in the Body Organs of the Standard Man
Table VIII	Organs of Standard Man—Mass and Effective Radius of Organs of the Adult Human Body
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TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_1H^3(H_2^3O)$ (β^-) (Sol)	**Body Tissue**	10^3	**0.1**	$\mathbf{2\times10^{-5}}$	**0.03**	$\mathbf{5\times10^{-6}}$
	Total Body	2×10^3	0.2	$\mathbf{2\times10^{-5}}$	0.05	7×10^{-6}
(H_2^3) (Immersion)	**Skin**	----------	----------	$\mathbf{2\times10^{-3}}$	----------	$\mathbf{4\times10^{-4}}$
$_4Be^7$ (ϵ, γ)	**GI (LLI)***	----------	**0.05**	10^{-5}	**0.02**	4×10^{-6}
	Total Body	600	6	$\mathbf{6\times10^{-6}}$	2	$\mathbf{2\times10^{-6}}$
(Sol)	Kidney	800	9	8×10^{-6}	3	3×10^{-6}
(Sol)	Liver	800	9	8×10^{-6}	3	3×10^{-6}
(Sol)	Bone	2×10^3	20	2×10^{-5}	7	6×10^{-6}
(Sol)	Spleen	4×10^3	50	4×10^{-5}	20	2×10^{-5}
(Insol)	**Lung**	----------	----------	$\mathbf{10^{-6}}$	----------	$\mathbf{4\times10^{-7}}$
(Insol)	**GI (LLI)**	----------	**0.05**	9×10^{-6}	**0.02**	3×10^{-6}
$_6C^{14}(CO_2)$ (β^-) (Sol)	**Fat**	300	**0.02**	$\mathbf{4\times10^{-6}}$	$\mathbf{8\times10^{-3}}$	$\mathbf{10^{-6}}$
(Sol)	Total Body	400	0.03	5×10^{-6}	0.01	2×10^{-6}
(Sol)	Bone	400	0.04	6×10^{-6}	0.01	2×10^{-6}

	(Immersion)	**Total Body**			5×10^{-5}		10^{-5}
$_{9}F^{18}(\beta^{+})$	(Sol)	**GI (SI)**		**0.02**	5×10^{-6}	8×10^{-3}	2×10^{-6}
		Bone and Teeth	20	0.2	3×10^{-5}	0.06	9×10^{-6}
		Total Body	20	0.3	4×10^{-5}	0.09	10^{-5}
	(Insol)	**GI (ULI)**		**0.01**	3×10^{-6}	5×10^{-3}	9×10^{-7}
		Lung			2×10^{-5}		6×10^{-6}
$_{11}Na^{22}(\beta^{+}, \gamma)$	(Sol)	**Total Body**	10	10^{-3}	2×10^{-7}	4×10^{-4}	6×10^{-8}
		GI (LLI)		0.01	2×10^{-6}	3×10^{-3}	7×10^{-7}
	(Insol)	**Lung**			9×10^{-9}		3×10^{-9}
		GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	5×10^{-8}
$_{11}Na^{24}(\beta^{-}, \gamma)$	(Sol)	**GI (SI)**		6×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		Total Body	7	0.01	2×10^{-6}	4×10^{-3}	6×10^{-7}
	(Insol)	**GI (LLI)**		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}
		Lung			8×10^{-7}		3×10^{-7}
$_{14}Si^{31}(\beta^{-}, \gamma)$	(Sol)	**GI (S)**		**0.03**	6×10^{-6}	9×10^{-3}	2×10^{-6}
		Lung	10	0.1	2×10^{-5}	0.05	7×10^{-6}
		Adrenal	30	0.3	4×10^{-5}	0.1	10^{-5}
		Total Body	30	0.3	4×10^{-5}	0.1	2×10^{-5}
		Testis	40	0.4	5×10^{-5}	0.1	2×10^{-5}
		Ovary	60	0.6	8×10^{-5}	0.2	3×10^{-5}
		Skin	100	1	2×10^{-4}	0.5	7×10^{-5}
	(Insol)	**GI (ULI)**		6×10^{-3}	10^{-6}	2×10^{-3}	3×10^{-7}
		Lung			10^{-5}		4×10^{-6}

*The abbreviations GI, S, SI, ULI, and LLI refer to gastrointestinal tract, stomach, small intestines, upper large intestine, and lower large intestine, respectively.

**It will be noted that the MPC values for the 168-hour week are not always precisely the same multiples of the MPC for the 40-hour week. Part of this is caused by rounding off the calculated values to one digit, but in some instances it is due to technical differences discussed in the ICRP report. Because of the uncertainties present in much of the biological data and because of individual variations, the differences are not considered significant. The MPC values for the 40-hour week are to be considered as basic for occupational exposure, and the values for the 168-hour week are basic for continuous exposure as in the case of the population at large.

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TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{15}P^{32}$ (β^-)	**Bone**	6	$\mathbf{5\times10^{-4}}$	$\mathbf{7\times10^{-8}}$	$\mathbf{2\times10^{-4}}$	$\mathbf{2\times10^{-8}}$
	Total Body	30	3×10^{-3}	4×10^{-7}	9×10^{-4}	10^{-7}
(Sol)	GI (LLI)	----------	3×10^{-3}	6×10^{-7}	9×10^{-4}	2×10^{-7}
	Liver	50	5×10^{-3}	6×10^{-7}	2×10^{-3}	2×10^{-7}
	Brain	300	0.02	3×10^{-6}	8×10^{-3}	10^{-6}
	Lung	----------	----------	$\mathbf{8\times10^{-8}}$	----------	$\mathbf{3\times10^{-8}}$
(Insol)	**GI (LLI)**	----------	$\mathbf{7\times10^{-4}}$	10^{-7}	$\mathbf{2\times10^{-4}}$	4×10^{-8}
$_{16}S^{35}$ (β^-)	**Testis**	90	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{9\times10^{-8}}$
	Total Body	400	7×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
(Sol)	Bone	800	0.02	2×10^{-6}	5×10^{-3}	8×10^{-7}
	Skin	3×10^3	0.07	10^{-5}	0.02	3×10^{-6}
	GI (LLI)	----------	0.2	4×10^{-5}	0.05	10^{-5}
	Lung	----------	----------	$\mathbf{3\times10^{-7}}$	----------	$\mathbf{9\times10^{-8}}$
(Insol)	**GI (LLI)**	----------	$\mathbf{8\times10^{-3}}$	10^{-6}	$\mathbf{3\times10^{-3}}$	5×10^{-7}
$_{17}Cl^{36}(\beta^-)$	**Total Body**	80	$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$	$\mathbf{8\times10^{-4}}$	$\mathbf{10^{-7}}$
(Sol)	GI (LLI)	----------	0.04	8×10^{-6}	0.01	3×10^{-6}
	Lung	----------	----------	$\mathbf{2\times10^{-8}}$	----------	$\mathbf{8\times10^{-9}}$
(Insol)	**GI (LLI)**	----------	$\mathbf{2\times10^{-3}}$	3×10^{-7}	$\mathbf{6\times10^{-4}}$	10^{-7}

$_{17}Cl^{38}(\beta^-,\gamma)$	(Sol)	**GI (S)**		**0.01**	3×10^{-6}	4×10^{-3}	9×10^{-7}
		Total Body	9	0.3	4×10^{-5}	0.1	2×10^{-5}
	(Insol)	**GI (S)**		**0.01**	2×10^{-6}	4×10^{-3}	7×10^{-7}
		Lung			10^{-5}		5×10^{-6}
$_{18}A^{37}(\epsilon)$	(Immersion)	**Skin**			6×10^{-3}		10^{-3}
$_{18}A^{41}(\beta^-,\gamma)$	(Immersion)	**Total Body**			2×10^{-6}		4×10^{-7}
$_{19}K^{42}$ (β^-,γ)		**GI (S)**		9×10^{-3}	2×10^{-6}	3×10^{-3}	7×10^{-7}
		Total Body	10	0.02	3×10^{-6}	8×10^{-3}	10^{-6}
		Brain	20	0.04	6×10^{-6}	0.01	2×10^{-6}
	(Sol)	Spleen	20	0.04	6×10^{-6}	0.01	2×10^{-6}
		Muscle	20	0.04	6×10^{-6}	0.02	2×10^{-6}
		Liver	50	0.08	10^{-5}	0.03	4×10^{-6}
	(Insol)	**GI (LLI)**		6×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
		Lung			9×10^{-7}		3×10^{-7}
$_{20}Ca^{45}$ (β^-)		**Bone**	30	3×10^{-4}	3×10^{-8}	9×10^{-5}	10^{-8}
	(Sol)	Total Body	200	2×10^{-3}	3×10^{-7}	7×10^{-4}	9×10^{-8}
		GI (LLI)		0.01	3×10^{-6}	4×10^{-3}	10^{-6}
		Lung			10^{-7}		4×10^{-8}
	(Insol)	**GI (LLI)**		5×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
$_{20}Ca^{47}$ (β^-,γ)		**Bone**	5	10^{-3}	2×10^{-7}	5×10^{-4}	6×10^{-8}
	(Sol)	GI (LLI)		2×10^{-3}	5×10^{-7}	8×10^{-4}	2×10^{-7}
		Total Body	10	4×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
	(Insol)	**GI (LLI)**		10^{-3}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Lung			2×10^{-7}		6×10^{-8}
$_{21}Sc^{46}$ (β^-,γ)		**GI (LLI)**		10^{-3}	2×10^{-7}	4×10^{-4}	8×10^{-8}
		Liver	10	6	2×10^{-7}	2	8×10^{-8}
	(Sol)	Kidney	10	6	3×10^{-7}	2	9×10^{-8}
		Total Body	20	6	3×10^{-7}	2	10^{-7}
		Bone	60	20	10^{-6}	8	4×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
(Insol)	**Lung**			2×10^{-8}		8×10^{-9}
	GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	7×10^{-8}
$_{21}Sc^{47}$ (β^-, γ)	**GI (LLI)**		3×10^{-3}	6×10^{-7}	9×10^{-4}	2×10^{-7}
	Liver	50	100	6×10^{-6}	50	2×10^{-6}
(Sol)	Kidney	60	200	8×10^{-6}	60	3×10^{-6}
	Bone	60	200	8×10^{-6}	60	3×10^{-6}
	Total Body	80	200	10^{-5}	80	3×10^{-6}
(Insol)	**GI (LLI)**		3×10^{-3}	5×10^{-7}	9×10^{-4}	2×10^{-7}
	Lung			10^{-6}		3×10^{-7}
$_{21}Sc^{48}$ (β^-, γ)	**GI (LLI)**		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	Total Body	9	50	2×10^{-6}	20	7×10^{-7}
(Sol)	Liver	9	50	2×10^{-6}	20	7×10^{-7}
	Kidney	10	80	3×10^{-6}	30	10^{-6}
	Bone	30	200	8×10^{-6}	60	3×10^{-6}
(Insol)	**GI (LLI)**		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}
	Lung			4×10^{-7}		10^{-7}

$_{23}V^{48}$ (β^+, ϵ, γ)		**GI (LLI)**		**9×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**6×10^{-8}**
		Kidney	8	0.03	3×10^{-7}	0.01	9×10^{-8}
	(Sol)	Total Body	10	0.04	4×10^{-7}	0.02	10^{-7}
		Spleen	20	0.06	5×10^{-7}	0.02	2×10^{-7}
		Liver	20	0.09	8×10^{-7}	0.03	3×10^{-7}
		Bone	60	0.2	2×10^{-6}	0.08	7×10^{-7}
	(Insol)	**Lung**			**6×10^{-8}**		**2×10^{-8}**
		GI (LLI)		**8×10^{-4}**	10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{24}Cr^{51}$ (ϵ, γ)		**GI (LLI)**		**0.05**	**10^{-5}**	**0.02**	**4×10^{-6}**
		Total Body	800	0.6	**10^{-5}**	0.2	**4×10^{-6}**
	(Sol)	Lung	10^3	1	2×10^{-5}	0.4	8×10^{-6}
		Prostate	2×10^3	2	3×10^{-5}	0.5	10^{-5}
		Thyroid	4×10^3	3	6×10^{-5}	1	2×10^{-5}
		Kidney	8×10^3	6	10^{-4}	2	4×10^{-5}
	(Insol)	**Lung**			**2×10^{-6}**		**8×10^{-7}**
		GI (LLI)		**0.05**	8×10^{-6}	**0.02**	3×10^{-6}
$_{25}Mn^{52}$ (β^+, ϵ, γ)		**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**3×10^{-4}**	**7×10^{-8}**
	(Sol)	Pancreas	5	0.01	4×10^{-7}	4×10^{-3}	2×10^{-7}
		Liver	6	0.01	5×10^{-7}	4×10^{-3}	2×10^{-7}
		Total Body	9	0.02	8×10^{-7}	7×10^{-3}	3×10^{-7}
	(Insol)	**Lung**			**10^{-7}**		**5×10^{-8}**
		GI (LLI)		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	**5×10^{-8}**
$_{25}Mn^{54}$ (ϵ, γ)		**GI (LLI)**		**4×10^{-3}**	8×10^{-7}	**10^{-3}**	3×10^{-7}
	(Sol)	**Liver**	20	0.01	**4×10^{-7}**	4×10^{-3}	**10^{-7}**
		Total Body	40	0.02	8×10^{-7}	8×10^{-3}	3×10^{-7}
		Pancreas	50	0.02	9×10^{-7}	9×10^{-3}	3×10^{-7}
	(Insol)	**Lung**			**4×10^{-8}**		**10^{-8}**
		GI (LLI)		**3×10^{-3}**	6×10^{-7}	**10^{-3}**	2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{25}Mn^{56}$ (β^-, γ)						
(Sol)	**GI (LLI)**	----	4×10^{-3}	8×10^{-7}	10^{-3}	3×10^{-7}
	Pancreas	2	0.2	6×10^{-6}	0.05	2×10^{-6}
	Liver	5	0.4	10^{-5}	0.1	5×10^{-6}
	Total Body	10	0.9	3×10^{-5}	0.3	10^{-5}
(Insol)	**GI (LLI)**	----	3×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
	Lung	----	----	5×10^{-6}	----	2×10^{-6}
$_{26}Fe^{55}$ (ϵ)						
(Sol)	**Spleen**	10^3	0.02	9×10^{-7}	8×10^{-3}	3×10^{-7}
	Liver	2×10^3	0.04	2×10^{-6}	0.01	5×10^{-7}
	Total Body	3×10^3	0.06	2×10^{-6}	0.02	8×10^{-7}
	Lung	4×10^3	0.07	3×10^{-6}	0.03	9×10^{-7}
	GI (LLI)	----	0.08	2×10^{-5}	0.03	6×10^{-6}
	Bone	7×10^3	0.1	5×10^{-6}	0.04	2×10^{-6}
(Insol)	**Lung**	----	----	10^{-6}	----	3×10^{-7}
	GI (LLI)	----	0.07	10^{-5}	0.02	4×10^{-6}
$_{26}Fe^{59}$ (β^-, γ)						
(Sol)	**GI (LLI)**	----	2×10^{-3}	4×10^{-7}	6×10^{-4}	10^{-7}
	Spleen	20	4×10^{-3}	10^{-7}	10^{-3}	5×10^{-8}
	Total Body	20	5×10^{-3}	2×10^{-7}	2×10^{-3}	7×10^{-8}
	Liver	30	6×10^{-3}	2×10^{-7}	2×10^{-3}	7×10^{-8}
	Lung	100	0.02	8×10^{-7}	7×10^{-3}	3×10^{-7}
	Bone	100	0.03	10^{-6}	0.01	4×10^{-7}

	(Insol)	**Lung**			5×10^{-8}		2×10^{-8}
		GI (LLI)		2×10^{-3}	3×10^{-7}	5×10^{-4}	9×10^{-8}
$_{27}Co^{57}$ (ϵ, γ, e^-)		**GI (LLI)**		**0.02**	3×10^{-6}	5×10^{-3}	10^{-6}
	(Sol)	Total Body	200	0.07	6×10^{-6}	0.03	2×10^{-6}
		Pancreas	700	0.2	2×10^{-5}	0.08	7×10^{-6}
		Liver	10^3	0.4	2×10^{-5}	0.1	6×10^{-6}
		Spleen	2×10^3	0.7	6×10^{-5}	0.2	2×10^{-5}
		Kidney	3×10^3	0.9	8×10^{-5}	0.3	3×10^{-5}
	(Insol)	**Lung**			2×10^{-7}		6×10^{-8}
		GI (LLI)		**0.01**	2×10^{-6}	4×10^{-3}	7×10^{-7}
$_{27}Co^{58m}$ (β^+, ϵ, γ)		**GI (LLI)**		**0.08**	2×10^{-5}	**0.03**	6×10^{-6}
	(Sol)	Total Body	200	2	10^{-4}	0.6	5×10^{-5}
		Pancreas	800	6	5×10^{-4}	2	2×10^{-4}
		Liver	10^3	9	4×10^{-4}	3	10^{-4}
		Spleen	2×10^3	20	10^{-3}	5	4×10^{-4}
		Kidney	3×10^3	20	2×10^{-3}	8	6×10^{-4}
	(Insol)	**Lung**			9×10^{-6}		3×10^{-6}
		GI (LLI)		**0.06**	10^{-5}	**0.02**	4×10^{-6}
$_{27}Co^{58}$ (β^+, ϵ)		**GI (LLI)**		4×10^{-3}	8×10^{-7}	10^{-3}	3×10^{-7}
	(Sol)	**Total Body**	30	0.01	10^{-6}	4×10^{-3}	3×10^{-7}
		Pancreas	200	0.06	5×10^{-6}	0.02	2×10^{-6}
		Liver	200	0.08	4×10^{-6}	0.03	10^{-6}
		Spleen	400	0.1	10^{-5}	0.05	4×10^{-6}
		Kidney	600	0.2	2×10^{-5}	0.07	6×10^{-6}
	(Insol)	**Lung**			5×10^{-8}		2×10^{-8}
		GI (LLI)		3×10^{-3}	5×10^{-7}	9×10^{-4}	2×10^{-7}
$_{27}Co^{60}$ (β^-, γ)		**GI (LLI)**		10^{-3}	3×10^{-7}	5×10^{-4}	10^{-7}
	(Sol)	**Total Body**	10	4×10^{-3}	4×10^{-7}	10^{-3}	10^{-7}
		Pancreas	70	0.02	2×10^{-6}	7×10^{-3}	6×10^{-7}
		Liver	90	0.03	10^{-6}	9×10^{-3}	5×10^{-7}
		Spleen	200	0.05	4×10^{-6}	0.02	2×10^{-6}
		Kidney	200	0.07	6×10^{-6}	0.03	2×10^{-6}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
	(Insol)	**Lung**			9×10^{-9}		3×10^{-9}
		GI (LLI)		10^{-3}	2×10^{-7}	3×10^{-4}	6×10^{-8}
$_{28}Ni^{59}$ (ϵ)	(Sol)	**Bone**	10^3	6×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
		Total Body	3×10^3	0.01	10^{-6}	4×10^{-3}	3×10^{-7}
		Liver	4×10^3	0.02	10^{-6}	6×10^{-3}	5×10^{-7}
		GI (LLI)		0.08	2×10^{-5}	0.03	6×10^{-6}
	(Insol)	**Lung**			8×10^{-7}		3×10^{-7}
		GI (LLI)		**0.06**	10^{-5}	**0.02**	3×10^{-6}
$_{28}Ni^{63}$ (β^-)	(Sol)	**Bone**	200	8×10^{-4}	6×10^{-8}	3×10^{-4}	2×10^{-8}
		Total Body	900	4×10^{-3}	4×10^{-7}	2×10^{-3}	10^{-7}
		Liver	10^3	6×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
		GI (LLI)		0.03	6×10^{-6}	0.01	2×10^{-6}
	(Insol)	**Lung**			3×10^{-7}		10^{-7}
		GI (LLI)		**0.02**	4×10^{-6}	7×10^{-3}	10^{-6}
$_{28}Ni^{65}$ (β^-, γ)	(Sol)	**GI (ULI)**		4×10^{-3}	9×10^{-7}	10^{-3}	3×10^{-7}
		Bone	4	0.1	10^{-5}	0.04	3×10^{-6}
		Total Body	10	0.4	3×10^{-5}	0.1	10^{-5}
		Liver	20	0.5	4×10^{-5}	0.2	10^{-5}

	(Insol)	**GI (ULI)**		**3×10^{-3}**	**5×10^{-7}**	**10^{-3}**	**2×10^{-7}**
		Lung			5×10^{-6}		2×10^{-6}
$_{29}Cu^{64}$ (β^-, β^+, ϵ)		**GI (LLI)**		**0.01**	**2×10^{-6}**	**3×10^{-3}**	**7×10^{-7}**
		Spleen	10	0.08	6×10^{-6}	0.03	2×10^{-6}
		Kidney	30	0.2	2×10^{-6}	0.07	5×10^{-6}
	(Sol)	Total Body	80	0.5	4×10^{-5}	0.2	10^{-5}
		Liver	100	0.6	5×10^{-5}	0.2	2×10^{-5}
		Heart	200	0.9	7×10^{-5}	0.3	3×10^{-5}
		Brain	600	4	3×10^{-4}	1	10^{-4}
	(Insol)	**GI (LLI)**		**6×10^{-3}**	**10^{-6}**	**2×10^{-3}**	**4×10^{-7}**
		Lung			7×10^{-6}		3×10^{-6}
$_{30}Zn^{65}$(β^+, ϵ, γ)		**Total Body**	60	3×10^{-3}	**10^{-7}**	**10^{-3}**	**4×10^{-8}**
		Prostate	70	4×10^{-3}	**10^{-7}**	**10^{-3}**	**4×10^{-8}**
		Liver	80	4×10^{-3}	**10^{-7}**	**10^{-3}**	**5×10^{-8}**
		Kidney	100	6×10^{-3}	2×10^{-7}	2×10^{-3}	7×10^{-8}
		GI (LLI)		6×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
	(Sol)	Pancreas	200	7×10^{-3}	3×10^{-7}	3×10^{-3}	9×10^{-8}
		Muscle	200	0.01	4×10^{-7}	4×10^{-3}	10^{-7}
		Ovary	300	0.01	5×10^{-7}	4×10^{-3}	2×10^{-7}
		Testis	400	0.02	6×10^{-7}	6×10^{-3}	2×10^{-7}
		Bone	700	0.04	10^{-6}	0.01	4×10^{-7}
	(Insol)	**Lung**			**6×10^{-8}**		**2×10^{-8}**
		GI (LLI)		**5×10^{-3}**	9×10^{-7}	**2×10^{-3}**	3×10^{-7}
$_{30}Zn^{69m}$(γ, e^-, β^-)		**GI (LLI)**		**2×10^{-3}**	**4×10^{-7}**	**7×10^{-4}**	**2×10^{-7}**
		Prostate	0.7	0.01	**4×10^{-7}**	4×10^{-3}	**10^{-7}**
		Pancreas	5	0.07	3×10^{-6}	0.02	9×10^{-7}
		Liver	8	0.1	5×10^{-6}	0.05	2×10^{-6}
		Kidney	10	0.2	8×10^{-6}	0.07	3×10^{-6}
	(Sol)	Ovary	10	0.2	8×10^{-6}	0.07	3×10^{-6}
		Total Body	30	0.5	2×10^{-5}	0.2	6×10^{-6}
		Testis	30	0.5	2×10^{-5}	0.2	6×10^{-6}
		Bone	40	0.6	2×10^{-5}	0.2	7×10^{-6}
		Muscle	100	2	8×10^{-5}	0.7	3×10^{-5}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
(Insol)	**GI (LLI)**	----------	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{10^{-7}}$
	Lung	----------	----------	2×10^{-6}	----------	8×10^{-7}
$_{30}Zn^{69}(\beta^-)$	**GI (S)**	----------	**0.05**	10^{-5}	**0.02**	4×10^{-6}
	Prostate	0.8	0.2	$\mathbf{7\times10^{-6}}$	0.07	$\mathbf{2\times10^{-6}}$
	Pancreas	5	1	5×10^{-5}	0.5	2×10^{-5}
	Liver	10	3	10^{-4}	1	4×10^{-5}
(Sol)	Ovary	20	4	10^{-4}	1	5×10^{-5}
	Kidney	20	4	2×10^{-4}	2	5×10^{-5}
	Testis	30	9	3×10^{-4}	3	10^{-4}
	Bone	40	10	4×10^{-4}	3	10^{-4}
	Total Body	50	10	5×10^{-4}	5	2×10^{-4}
	Muscle	200	60	2×10^{-3}	20	7×10^{-4}
(Insol)	**GI (S)**	----------	**0.05**	$\mathbf{9\times10^{-6}}$	**0.02**	$\mathbf{3\times10^{-6}}$
	Lung	----------	----------	5×10^{-5}	----------	2×10^{-5}
$_{31}Ga^{72}$ (β^-, γ)	**GI (LLI)**	----------	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{8\times10^{-8}}$
	Liver	5	9	4×10^{-6}	3	10^{-6}
(Sol)	Total Body	10	20	8×10^{-6}	6	3×10^{-6}
	Bone	10	20	10^{-5}	8	3×10^{-6}
	Spleen	10	20	10^{-5}	8	4×10^{-6}
	Kidney	10	20	10^{-5}	8	4×10^{-6}

	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**4×10^{-4}**	**6×10^{-8}**
		Lung			10^{-6}		4×10^{-7}
$_{32}Ge^{71}$ (ϵ)	(Sol)	**GI (LLI)**		**0.05**	**10^{-5}**	**0.02**	**4×10^{-6}**
		Kidney	100	10	5×10^{-5}	4	2×10^{-5}
		Liver	10^3	100	6×10^{-4}	50	2×10^{-4}
		Total Body	2×10^3	200	9×10^{-4}	70	3×10^{-4}
	(Insol)	**Lung**			**6×10^{-6}**		**2×10^{-6}**
		GI (LLI)		**0.05**	8×10^{-6}	**0.02**	3×10^{-6}
$_{33}As^{73}$ (ϵ, γ)	(Sol)	**GI (LLI)**		**0.01**	3×10^{-6}	**5×10^{-3}**	10^{-6}
		Total Body	300	0.2	**2×10^{-6}**	0.06	**7×10^{-7}**
		Kidney	600	0.3	4×10^{-6}	0.1	10^{-6}
		Liver	10^3	0.5	6×10^{-6}	0.2	2×10^{-6}
	(Insol)	**Lung**			**4×10^{-7}**		**10^{-7}**
		GI (LLI)		**0.01**	2×10^{-6}	**5×10^{-3}**	8×10^{-7}
$_{33}As^{74}$(β^-, β^+, ϵ, γ)	(Sol)	**GI (LLI)**		**2×10^{-3}**	**3×10^{-7}**	**5×10^{-4}**	**10^{-7}**
		Total Body	40	0.07	8×10^{-7}	0.02	3×10^{-7}
		Kidney	80	0.1	2×10^{-6}	0.05	6×10^{-7}
		Liver	100	0.2	3×10^{-6}	0.08	10^{-6}
	(Insol)	Lung			**10^{-7}**		**4×10^{-8}**
		GI (LLI)		**2×10^{-3}**	3×10^{-7}	**5×10^{-4}**	9×10^{-8}
$_{33}As^{76}$ (β^-, γ)	(Sol)	**GI (LLI)**		**6×10^{-4}**	**10^{-7}**	**2×10^{-4}**	**4×10^{-8}**
		Total Body	20	0.4	5×10^{-6}	0.1	2×10^{-6}
		Kidney	20	0.6	8×10^{-6}	0.2	3×10^{-6}
		Liver	40	1	10^{-5}	0.4	5×10^{-6}
	(Insol)	**GI (LLI)**		**6×10^{-4}**	**10^{-7}**	**2×10^{-4}**	**3×10^{-8}**
		Lung			6×10^{-7}		2×10^{-7}
$_{33}As^{77}$(β^-, γ)	(Sol)	**GI (LLI)**		**2×10^{-3}**	**5×10^{-7}**	**8×10^{-4}**	**2×10^{-7}**
		Total Body	80	2	2×10^{-5}	0.5	7×10^{-6}
		Kidney	100	2	2×10^{-5}	0.7	8×10^{-6}
		Liver	200	4	5×10^{-5}	1	2×10^{-5}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
	(Insol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	8×10^{-4}	10^{-7}
		Lung			2×10^{-6}		6×10^{-7}
$_{34}Se^{75}(\epsilon, \gamma)$		**Kidney**	90	9×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
		Total Body	100	0.01	10^{-6}	3×10^{-3}	5×10^{-7}
	(Sol)	Liver	100	0.01	2×10^{-6}	4×10^{-3}	5×10^{-7}
		Spleen	200	0.02	3×10^{-6}	8×10^{-3}	10^{-6}
		GI (LLI)		0.07	2×10^{-5}	0.03	6×10^{-6}
	(Insol)	**Lung**			10^{-7}		4×10^{-8}
		GI (LLI)		8×10^{-3}	10^{-6}	3×10^{-3}	5×10^{-7}
$_{34}Br^{82}$ (β^-, γ)	(Sol)	**Total Body**	10	8×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
		GI (SI)		8×10^{-3}	2×10^{-6}	3×10^{-3}	6×10^{-7}
	(Insol)	**GI (LLI)**		10^{-3}	2×10^{-7}	4×10^{-4}	6×10^{-8}
		Lung			6×10^{-7}		2×10^{-7}
$_{36}Kr^{85m}$ (β^-, γ)	(Immersion)	**Total Body**			6×10^{-6}		10^{-6}
$_{36}Kr^{85}$ (β^-)	(Immersion)	**Total Body**			10^{-5}		3×10^{-6}
$_{36}Kr^{87}$ (β^-, γ)	(Immersion)	**Total Body**			10^{-6}		2×10^{-7}

$_{37}Rb^{86}$ (β^-, γ)	(Sol)	**Total Body**	30	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{7\times10^{-4}}$	$\mathbf{10^{-7}}$
		Pancreas	30	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{7\times10^{-4}}$	$\mathbf{10^{-7}}$
		Liver	40	3×10^{-3}	4×10^{-7}	10^{-3}	$\mathbf{10^{-7}}$
		Spleen	50	3×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
		Muscle	70	5×10^{-3}	7×10^{-7}	2×10^{-3}	2×10^{-7}
		GI (LLI)		0.01	3×10^{-6}	5×10^{-3}	10^{-6}
	(Insol)	**Lung**			$\mathbf{7\times10^{-8}}$		$\mathbf{2\times10^{-8}}$
		GI (LLI)		$\mathbf{7\times10^{-4}}$	10^{-7}	$\mathbf{2\times10^{-4}}$	4×10^{-8}
$_{37}Rb^{87}$ (β^-)	(Sol)	**Pancreas**	200	$\mathbf{3\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Total Body	200	4×10^{-3}	6×10^{-7}	2×10^{-3}	$\mathbf{2\times10^{-7}}$
		Liver	200	5×10^{-3}	7×10^{-7}	2×10^{-3}	$\mathbf{2\times10^{-7}}$
		Muscle	400	7×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		Spleen	400	7×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		GI (LLI)		0.1	2×10^{-5}	0.03	8×10^{-6}
	(Insol)	**Lung**			$\mathbf{7\times10^{-8}}$		$\mathbf{2\times10^{-8}}$
		GI (LLI)		$\mathbf{5\times10^{-3}}$	9×10^{-7}	$\mathbf{2\times10^{-3}}$	3×10^{-7}
$_{38}Sr^{85m}$ (ϵ, γ)	(Sol)	**GI (SI)**		**0.2**	$\mathbf{4\times10^{-5}}$	**0.07**	$\mathbf{10^{-5}}$
		Total Body	50	3	2×10^{-4}	1	8×10^{-5}
		Bone	70	5	4×10^{-4}	2	10^{-4}
	(Insol)	**GI (SI)**		**0.2**	$\mathbf{3\times10^{-5}}$	**0.07**	$\mathbf{10^{-5}}$
		Lung			9×10^{-5}		3×10^{-5}
$_{38}Sr^{85}$ (ϵ, γ)	(Sol)	**Total Body**	60	$\mathbf{3\times10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{8\times10^{-8}}$
		Bone	70	4×10^{-3}	4×10^{-7}	2×10^{-3}	10^{-7}
		GI (LLI)		7×10^{-3}	2×10^{-6}	2×10^{-3}	5×10^{-7}
	(Insol)	**Lung**			$\mathbf{10^{-7}}$		$\mathbf{4\times10^{-8}}$
		GI (LLI)		$\mathbf{5\times10^{-3}}$	9×10^{-7}	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$
$_{38}Sr^{89}$ (β^-)	(Sol)	**Bone**	4	$\mathbf{3\times10^{-4}}$	$\mathbf{3\times10^{-8}}$	$\mathbf{10^{-4}}$	$\mathbf{10^{-8}}$
		GI (LLI)		10^{-v}	3×10^{-7}	4×10^{-4}	9×10^{-8}
		Total Body	40	2×10^{-3}	2×10^{-7}	7×10^{-4}	6×10^{-8}
	(Insol)	**Lung**			$\mathbf{4\times10^{-8}}$		$\mathbf{10^{-8}}$
		GI (LLI)		8×10^{-4}	10^{-7}	$\mathbf{3\times10^{-4}}$	5×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{38}Sr^{90}$ (β^-)						
(Sol)	**Bone**	2	4×10^{-6}	3×10^{-10}	10^{-6}	10^{-10}
	Total Body	20	10^{-5}	9×10^{-10}	4×10^{-6}	3×10^{-10}
	GI (LLI)		10^{-3}	3×10^{-7}	5×10^{-4}	10^{-7}
(Insol)	**Lung**			5×10^{-9}		2×10^{-9}
	GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	6×10^{-8}
$_{38}Sr^{91}$ (β^-, γ)						
(Sol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	7×10^{-4}	2×10^{-7}
	Bone	3	0.02	2×10^{-6}	7×10^{-3}	5×10^{-7}
	Total Body	9	0.07	6×10^{-6}	0.02	2×10^{-6}
(Insol)	**GI (LLI)**		10^{-3}	3×10^{-7}	5×10^{-4}	9×10^{-8}
	Lung			10^{-6}		4×10^{-7}
$_{38}Sr^{92}$ (β^-, γ)						
(Sol)	**GI (ULI)**		2×10^{-3}	4×10^{-7}	7×10^{-4}	2×10^{-7}
	Bone	2	0.05	4×10^{-6}	0.02	2×10^{-6}
	Total Body	8	0.2	2×10^{-5}	0.07	6×10^{-6}
(Insol)	**GI (ULI)**		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
	Lung			3×10^{-6}		10^{-6}
$_{39}Y^{90}$ (β^-)						
(Sol)	**GI (LLI)**		6×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
	Bone	3	10	5×10^{-7}	4	2×10^{-7}
	Total Body	20	80	3×10^{-6}	30	10^{-6}

	(Insol)	**GI (LLI)**		**6×10^{-4}**	**10^{-7}**	**2×10^{-4}**	**3×10^{-8}**
		Lung			3×10^{-7}		10^{-7}
$_{39}Y^{91m}$ (β^-, γ)	(Sol)	**GI (SI)**		**0.1**	**2×10^{-5}**	**0.03**	**8×10^{-6}**
		Bone	5	10^3	6×10^{-5}	400	2×10^{-5}
		Total Body	20	6×10^3	2×10^{-4}	2×10^3	8×10^{-5}
	(Insol)	**GI (SI)**		**0.1**	**2×10^{-5}**	**0.03**	**6×10^{-6}**
		Lung			4×10^{-5}		10^{-5}
$_{39}Y^{91}$ (β^-, γ)	(Sol)	**GI (LLI)**		**8×10^{-4}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
		Bone	5	0.8	**4×10^{-8}**	0.3	**10^{-8}**
		Total Body	30	5	2×10^{-7}	2	8×10^{-8}
	(Insol)	**Lung**			**3×10^{-8}**		**10^{-8}**
		GI (LLI)		**8×10^{-4}**	10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{39}Y^{92}$ (β^-, γ)	(Sol)	**GI (ULI)**		**2×10^{-3}**	**4×10^{-7}**	**6×10^{-4}**	**10^{-7}**
		Bone	2	100	6×10^{-6}	40	2×10^{-6}
		Total Body	10	800	3×10^{-5}	300	10^{-5}
	(Insol)	**GI (ULI)**		**2×10^{-3}**	**3×10^{-7}**	**6×10^{-4}**	**10^{-7}**
		Lung			3×10^{-6}		10^{-6}
$_{39}Y^{93}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**8×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**6×10^{-8}**
		Bone	2	50	2×10^{-6}	20	7×10^{-7}
		Total Body	10	250	10^{-5}	90	4×10^{-6}
	(Insol)	**GI (LLI)**		**8×10^{-4}**	**10^{-7}**	**3×10^{-4}**	**5×10^{-8}**
		Lung			10^{-6}		4×10^{-7}
$_{40}Zr^{93}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**0.02**	5×10^{-6}	**8×10^{-3}**	2×10^{-6}
		Bone	100	3	**10^{-7}**	0.9	**4×10^{-8}**
		Kidney	300	6	3×10^{-7}	2	9×10^{-8}
		Spleen	500	10	4×10^{-7}	3	10^{-7}
		Total Body	900	20	8×10^{-7}	6	3×10^{-7}
		Liver	10^3	30	10^{-6}	9	4×10^{-7}
	(Insol)	**Lung**			**3×10^{-7}**		**10^{-7}**
		GI (LLI)		**0.02**	4×10^{-6}	**8×10^{-3}**	10^{-6}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{40}Zr^{95}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	6×10^{-4}	10^{-7}
		Total Body	20	3	10^{-7}	1	4×10^{-8}
		Bone	30	4	2×10^{-7}	2	6×10^{-8}
		Kidney	30	4	2×10^{-7}	2	6×10^{-8}
		Liver	40	6	3×10^{-7}	2	9×10^{-8}
		Spleen	40	7	3×10^{-7}	2	10^{-7}
	(Insol)	**Lung**			3×10^{-8}		10^{-8}
		GI (LLI)		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
$_{40}Zr^{97}$ (β^-, γ)	(Sol)	**GI (LLI)**		5×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
		Bone	5	60	3×10^{-6}	20	10^{-6}
		Kidney	8	100	5×10^{-6}	40	2×10^{-6}
		Total Body	9	100	5×10^{-6}	40	2×10^{-6}
		Liver	10	200	7×10^{-6}	60	3×10^{-6}
		Spleen	10	200	8×10^{-6}	60	3×10^{-6}
	(Insol)	**GI (LLI)**		5×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
		Lung			6×10^{-7}		2×10^{-7}

$_{41}Nb^{93m}$ (γ, e^-)	(Sol)	**GI (LLI)**		**0.01**	3×10^{-6}	4×10^{-3}	9×10^{-7}
		Bone	200	3	10^{-7}	1	4×10^{-8}
		Kidney	300	5	2×10^{-7}	2	7×10^{-8}
		Spleen	400	5	2×10^{-7}	2	8×10^{-8}
		Liver	400	6	3×10^{-7}	2	9×10^{-8}
		Total Body	500	8	3×10^{-7}	3	10^{-7}
	(Insol)	**Lung**			2×10^{-7}		5×10^{-8}
		GI (LLI)		**0.01**	2×10^{-6}	4×10^{-3}	7×10^{-7}
$_{41}Nb^{95}$ (β^-, γ)	(Sol)	**GI (LLI)**		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
		Total Body	40	10	5×10^{-7}	4	2×10^{-7}
		Liver	60	20	7×10^{-7}	6	3×10^{-7}
		Kidney	60	20	8×10^{-7}	6	3×10^{-7}
		Bone	80	20	9×10^{-7}	7	3×10^{-7}
		Spleen	80	20	10^{-6}	7	3×10^{-7}
	(Insol)	**Lung**			10^{-7}		3×10^{-8}
		GI (LLI)		3×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
$_{41}Nb^{97}$ (β^-, γ)	(Sol)	**GI (ULI)**		**0.03**	6×10^{-6}	9×10^{-3}	2×10^{-6}
		Bone	10	2×10^{3}	9×10^{-5}	700	3×10^{-5}
		Kidney	20	4×10^{3}	2×10^{-4}	10^{3}	6×10^{-5}
		Total Body	20	4×10^{3}	2×10^{-4}	10^{3}	6×10^{-5}
		Liver	30	4×10^{3}	2×10^{-4}	2×10^{3}	7×10^{-5}
		Spleen	30	5×10^{3}	2×10^{-4}	2×10^{3}	7×10^{-5}
	(Insol)	**GI (ULI)**		**0.03**	5×10^{-6}	9×10^{-3}	2×10^{-6}
		Lung			2×10^{-5}		7×10^{-6}
$_{42}Mo^{99}$ (β^-, γ)	(Sol)	**Kidney**	8	5×10^{-3}	7×10^{-7}	2×10^{-3}	3×10^{-7}
		GI (LLI)		7×10^{-3}	2×10^{-6}	2×10^{-3}	5×10^{-7}
		Liver	20	0. 01.	2×10^{-6}	5×10^{-3}	6×10^{-7}
		Total Body	40	0.02	3×10^{-6}	8×10^{-3}	10^{-6}
	(Insol)	**GI (LLI)**		10^{-3}	2×10^{-7}	4×10^{-4}	7×10^{-8}
		Lung			5×10^{-7}		2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{43}Tc^{96m}$ (ϵ, γ, e^-)		**GI (LLI)**		**0.4**	**8×10^{-5}**	**0.1**	**3×10^{-5}**
		Kidney	60	3	4×10^{-4}	1	10^{-4}
		Total Body	70	4	4×10^{-4}	1	10^{-4}
	(Sol)	Liver	800	40	4×10^{-3}	14	10^{-3}
		Lung	2×10^3	130	0.01	40	5×10^{-3}
		Bone	10^4	700	0.08	200	0.03
		Skin	2×10^4	800	0.09	300	0.03
	(Insol)	**Lung**			**3×10^{-5}**		**10^{-5}**
		GI (LLI)		**0.3**	5×10^{-5}	**0.1**	2×10^{-5}
$_{43}Tc^{96}$ (ϵ, γ)		**GI (LLI)**		**3×10^{-3}**	**6×10^{-7}**	**10^{-3}**	**2×10^{-7}**
		Kidney	10	0.03	3×10^{-6}	0.01	10^{-6}
		Total Body	10	0.03	4×10^{-6}	0.01	10^{-6}
	(Sol)	Liver	200	0.4	4×10^{-5}	0.1	10^{-5}
		Lung	500	1	10^{-4}	0.4	4×10^{-5}
		Bone	2×10^3	4	5×10^{-4}	1	2×10^{-4}
		Skin	10^4	20	3×10^{-3}	9	9×10^{-4}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**5×10^{-4}**	**8×10^{-8}**
		Lung			3×10^{-7}		9×10^{-8}

$_{43}Tc^{97m}$ (ϵ, γ, e^-)		**GI (LLI)**		**0.01**	**2×10^{-6}**	**4×10^{-3}**	**8×10^{-7}**
		Kidney	20	0.03	4×10^{-6}	0.01	10^{-6}
		Total Body	200	0.4	4×10^{-5}	0.1	2×10^{-5}
	(Sol)	Liver	200	0.4	5×10^{-5}	0.1	2×10^{-5}
		Skin	500	1	10^{-4}	0.3	4×10^{-5}
		Bone	700	1	10^{-4}	0.5	5×10^{-5}
		Lung	2×10^{3}	4	4×10^{-4}	1	2×10^{-4}
	(Insol)	**Lung**			**2×10^{-7}**		**5×10^{-8}**
		GI (LLI)		**5×10^{-3}**	9×10^{-7}	**2×10^{-3}**	3×10^{-7}
$_{43}Tc^{97}$ (ϵ)		**GI (LLI)**		**0.05**	**10^{-5}**	**0.02**	**4×10^{-6}**
		Kidney	60	0.1	**10^{-5}**	0.04	**4×10^{-6}**
		Liver	800	2	2×10^{-4}	0.5	6×10^{-5}
	(Sol)	Total Body	10^{3}	2	2×10^{-4}	0.6	7×10^{-5}
		Bone	6×10^{3}	10	10^{-3}	4	4×10^{-4}
		Lung	9×10^{3}	20	2×10^{-3}	6	7×10^{-4}
		Skin	3×10^{4}	60	6×10^{-3}	20	2×10^{-3}
	(Insol)	**Lung**			**3×10^{-7}**		**10^{-7}**
		GI (LLI)		**0.02**	4×10^{-6}	**8×10^{-3}**	10^{-6}
$_{43}Tc^{99m}$ (β^-, γ)		**GI (ULI)**		**0.2**	**4×10^{-5}**	**0.06**	**10^{-5}**
		Total Body	200	2	2×10^{-4}	0.8	9×10^{-5}
		Kidney	800	7	8×10^{-4}	3	3×10^{-4}
	(Sol)	Liver	10^{4}	100	0.01	30	4×10^{-3}
		Lung	2×10^{4}	200	0.02	70	8×10^{-3}
		Bone	10^{5}	10^{3}	0.1	400	0.04
		Skin	10^{5}	10^{3}	0.1	400	0.04
	(Insol)	**GI (ULI)**		**0.08**	**10^{-5}**	**0.03**	**5×10^{-6}**
		Lung			8×10^{-5}		3×10^{-5}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{43}Tc^{99}$ (β^-)						
(Sol)	**GI (LLI)**		**0.01**	$\mathbf{2\times10^{-6}}$	$\mathbf{3\times10^{-3}}$	$\mathbf{7\times10^{-7}}$
	Kidney	10	0.02	3×10^{-6}	8×10^{-3}	9×10^{-7}
	Liver	200	0.3	4×10^{-5}	0.1	10^{-5}
	Total Body	200	0.4	4×10^{-5}	0.1	10^{-5}
	Skin	400	0.7	7×10^{-5}	0.2	3×10^{-5}
	Bone	500	0.9	9×10^{-5}	0.3	3×10^{-5}
	Lung	2×10^3	4	4×10^{-4}	1	10^{-4}
(Insol)	**Lung**			$\mathbf{6\times10^{-8}}$		$\mathbf{2\times10^{-8}}$
	GI (LLI)		$\mathbf{5\times10^{-3}}$	8×10^{-7}	$\mathbf{2\times10^{-3}}$	3×10^{-7}
$_{44}Ru^{97}$ (ϵ, γ, e^-)						
(Sol)	**GI (LLI)**		**0.01**	$\mathbf{2\times10^{-6}}$	$\mathbf{4\times10^{-3}}$	$\mathbf{8\times10^{-7}}$
	Kidney	30	0.4	5×10^{-6}	0.1	10^{-6}
	Total Body	100	2	3×10^{-5}	0.7	9×10^{-6}
	Bone	900	10	2×10^{-4}	5	6×10^{-5}
(Insol)	**GI (LLI)**		**0.01**	$\mathbf{2\times10^{-6}}$	$\mathbf{3\times10^{-3}}$	$\mathbf{6\times10^{-7}}$
	Lung			$\mathbf{2\times10^{-6}}$		7×10^{-7}
$_{44}Ru^{103}$ (β^-, γ, e^-)						
(Sol)	**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{8\times10^{-4}}$	$\mathbf{2\times10^{-7}}$
	Kidney	20	0.08	10^{-6}	0.03	3×10^{-7}
	Total Body	50	0.2	3×10^{-6}	0.08	9×10^{-7}
	Bone	100	0.6	7×10^{-6}	0.2	2×10^{-6}

	(Insol)	**Lung**			$\mathbf{8\times10^{-8}}$		$\mathbf{3\times10^{-8}}$
		GI (LLI)		$\mathbf{2\times10^{-3}}$	4×10^{-7}	$\mathbf{8\times10^{-4}}$	10^{-7}
$_{44}Ru^{105}$ (β^-, γ, e^-)	(Sol)	**GI (ULI)**		$\mathbf{3\times10^{-3}}$	$\mathbf{7\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Kidney	**2**	0.3	3×10^{-6}	0.09	10^{-6}
		Total Body	20	3	4×10^{-5}	0.9	10^{-5}
		Bone	40	6	8×10^{-5}	2	3×10^{-5}
	(Insol)	**GI (ULI)**		$\mathbf{3\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Lung			4×10^{-6}		10^{-6}
$_{44}Ru^{106}$ (β^-, γ)	(Sol)	**GI (LLI)**		$\mathbf{4\times10^{-4}}$	$\mathbf{8\times10^{-8}}$	$\mathbf{10^{-4}}$	$\mathbf{3\times10^{-8}}$
		Kidney	3	0.01	10^{-7}	4×10^{-3}	5×10^{-8}
		Bone	10	0.04	5×10^{-7}	0.01	2×10^{-7}
		Total Body	10	0.06	7×10^{-7}	0.02	3×10^{-7}
	(Insol)	**Lung**			$\mathbf{6\times10^{-9}}$		$\mathbf{2\times10^{-9}}$
		GI (LLI)		$\mathbf{3\times10^{-4}}$	6×10^{-8}	$\mathbf{10^{-4}}$	2×10^{-8}
$_{45}Rh^{103m}$ (γ, e^-)	(Sol)	**GI (S)**		**0.4**	$\mathbf{8\times10^{-5}}$	**0.1**	$\mathbf{3\times10^{-5}}$
		Kidney	200	20	10^{-3}	7	4×10^{-4}
		Spleen	200	30	2×10^{-3}	10	6×10^{-4}
		Total Body	400	40	3×10^{-3}	20	10^{-3}
		Liver	700	80	5×10^{-3}	30	2×10^{-3}
		Bone	10^3	100	9×10^{-3}	50	3×10^{-3}
	(Insol)	**GI (S)**		**0.3**	$\mathbf{6\times10^{-5}}$	**0.1**	$\mathbf{2\times10^{-5}}$
		Lung			3×10^{-4}		10^{-4}
$_{45}Rh^{105}$ (β^-, γ)	(Sol)	**GI (LLI)**		$\mathbf{4\times10^{-3}}$	$\mathbf{8\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$
		Bone	200	8×10^{-3}	5×10^{-5}	3×10^{-3}	2×10^{-5}
		Kidney	40	0.1	9×10^{-6}	0.05	3×10^{-6}
		Spleen	60	0.2	10^{-5}	0.07	5×10^{-6}
		Total Body	100	0.4	2×10^{-5}	0.1	7×10^{-6}
		Liver	200	0.6	4×10^{-5}	0.2	10^{-5}
	(Insol)	**GI (LLI)**		$\mathbf{3\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Lung			2×10^{-6}		8×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{46}Pd^{103}$ (ϵ, γ, e^-)		**GI (LLI)**		**0.01**	2×10^{-6}	$\mathbf{3\times10^{-3}}$	8×10^{-7}
	(Sol)	**Kidney**	20	0.02	$\mathbf{10^{-6}}$	7×10^{-3}	$\mathbf{5\times10^{-7}}$
		Spleen	100	0.1	8×10^{-6}	0.04	3×10^{-6}
		Liver	100	0.1	8×10^{-6}	0.04	3×10^{-6}
		Total Body	300	0.4	2×10^{-5}	0.1	8×10^{-6}
	(Insol)	**Lung**			$\mathbf{7\times10^{-7}}$		$\mathbf{3\times10^{-7}}$
		GI (LLI)		$\mathbf{8\times10^{-3}}$	10^{-6}	$\mathbf{3\times10^{-3}}$	5×10^{-7}
$_{46}Pd^{109}$ (β^-, γ, e^-)		**GI (LLI)**		$\mathbf{3\times10^{-3}}$	$\mathbf{6\times10^{-7}}$	$\mathbf{9\times10^{-4}}$	$\mathbf{2\times10^{-7}}$
	(Sol)	Kidney	7	0.06	4×10^{-6}	0.02	10^{-6}
		Spleen	30	0.3	2×10^{-5}	0.09	5×10^{-6}
		Liver	40	0.3	2×10^{-5}	0.1	7×10^{-6}
		Total Body	50	0.4	3×10^{-5}	0.1	9×10^{-6}
	(Insol)	**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$	$\mathbf{7\times10^{-4}}$	$\mathbf{10^{-7}}$
		Lung			3×10^{-6}		10^{-6}
$_{47}Ag^{105}$ (ϵ, γ)		**GI (LLI)**		$\mathbf{3\times10^{-3}}$	$\mathbf{6\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
	(Sol)	Total Body	30	0.6	3×10^{-6}	0.2	10^{-6}
		Kidney	30	0.7	3×10^{-6}	0.2	10^{-6}
		Liver	70	1	6×10^{-6}	0.5	2×10^{-6}
		Bone	200	4	2×10^{-5}	1	6×10^{-6}

	(Insol)	**Lung**			**8×10^{-8}**		**3×10^{-8}**
		GI (LLI)		**3×10^{-3}**	5×10^{-7}	**10^{-3}**	2×10^{-7}
$_{47}Ag^{110m}(\beta^-, \gamma)$		**GI (LLI)**		**9×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**7×10^{-8}**
		Kidney	10	0.2	8×10^{-7}	0.06	3×10^{-7}
	(Sol)	Total Body	10	0.2	9×10^{-7}	0.07	3×10^{-7}
		Liver	20	0.4	2×10^{-6}	0.1	5×10^{-7}
		Bone	40	0.7	3×10^{-6}	0.2	10^{-6}
	(Insol)	**Lung**			**10^{-8}**		**3×10^{-9}**
		GI (LLI)		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{47}Ag^{111}$ (β^-, γ)		**GI (LLI)**		**10^{-3}**	**3×10^{-7}**	**4×10^{-4}**	**10^{-7}**
		Kidney	20	0.7	3×10^{-6}	0.2	10^{-6}
	(Sol)	Total Body	50	1	6×10^{-6}	0.5	2×10^{-6}
		Bone	60	2	8×10^{-6}	0.6	3×10^{-6}
		Liver	80	2	10^{-5}	0.8	3×10^{-6}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**4×10^{-4}**	**8×10^{-8}**
		Lung			3×10^{-7}		9×10^{-8}
$_{48}Cd^{109}$ (ϵ, γ, e^-)	(Sol)	**GI (CLLI)**		**5×10^{-3}**	10^{-6}	**2×10^{-3}**	4×10^{-7}
		Liver	20	0.05	**5×10^{-8}**	0.02	**2×10^{-8}**
		Kidney	20	0.05	6×10^{-8}	0.02	**2×10^{-8}**
		Total Body	200	0.5	5×10^{-7}	0.2	2×10^{-7}
	(Insol)	**Lung**			**7×10^{-8}**		**3×10^{-8}**
		GI (LLI)		**5×10^{-3}**	9×10^{-7}	**2×10^{-3}**	3×10^{-7}
$_{48}Cd^{115m}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**7×10^{-4}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
		Liver	3	0.03	**4×10^{-8}**	0.01	**10^{-8}**
		Kidney	4	0.04	**4×10^{-8}**	0.01	2×10^{-8}
		Total Body	30	0.4	4×10^{-7}	0.1	10^{-7}
	(Insol)	**Lung**			**4×10^{-8}**		**10^{-8}**
		GI (LLI)		**7×10^{-4}**	10^{-7}	**3×10^{-4}**	4×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{48}Cd^{115}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{8\times10^{-8}}$
		Liver	3	0.6	6×10^{-7}	0.2	2×10^{-7}
		Kidney	5	0.8	8×10^{-7}	0.3	3×10^{-7}
		Total Body	30	5	5×10^{-6}	2	2×10^{-6}
	(Insol)	**GI (LLI)**		$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{6\times10^{-8}}$
		Lung			6×10^{-7}		2×10^{-7}
$_{49}In^{113m}$ (γ, e^-)	(Sol)	**GI (ULI)**		**0.04**	$\mathbf{8\times10^{-6}}$	**0.01**	$\mathbf{3\times10^{-6}}$
		Kidney	30	200	2×10^{-4}	70	6×10^{-5}
		Spleen	30	200	2×10^{-4}	70	6×10^{-5}
		Liver	50	300	3×10^{-4}	100	9×10^{-5}
		Total Body	70	400	4×10^{-4}	200	10^{-4}
		Bone	90	600	5×10^{-4}	200	2×10^{-4}
		Skin	100	900	8×10^{-4}	300	3×10^{-4}
		Thyroid	500	3×10^3	3×10^{-3}	10^3	10^{-3}
	(Insol)	**GI (ULI)**		**0.04**	$\mathbf{7\times10^{-6}}$	**0.01**	$\mathbf{2\times10^{-6}}$
		Lung			5×10^{-5}		2×10^{-5}

$_{49}In^{114m}$ (β^-, ϵ, γ, e^-)		**GI (LLI)**		**5×10^{-4}**	**10^{-7}**	**2×10^{-4}**	**4×10^{-8}**
		Kidney	6	0.1	**10^{-7}**	0.04	**4×10^{-8}**
		Spleen	7	0.1	**10^{-7}**	0.04	**4×10^{-8}**
	(Sol)	Liver	10	0.2	2×10^{-7}	0.07	6×10^{-8}
		Bone	10	0.3	2×10^{-7}	0.09	8×10^{-8}
		Skin	20	0.4	3×10^{-7}	0.1	10^{-7}
		Total Body	20	0.4	4×10^{-7}	0.1	10^{-7}
		Thyroid	50	0.9	8×10^{-7}	0.3	3×10^{-7}
	(Insol)	**Lung**			**2×10^{-8}**		**7×10^{-9}**
		GI (LLI)		**5×10^{-4}**	8×10^{-8}	**2×10^{-4}**	3×10^{-8}
$_{49}In^{115m}$ (β_-, γ, e^-)		**GI (ULI)**		**0.01**	**2×10^{-6}**	**4×10^{-3}**	**8×10^{-7}**
		Kidney	30	80	7×10^{-5}	30	2×10^{-5}
		Spleen	30	80	7×10^{-5}	30	2×10^{-5}
	(Sol)	Liver	50	100	10^{-4}	40	4×10^{-5}
		Total Body	80	200	2×10^{-4}	60	6×10^{-5}
		Thyroid	80	200	2×10^{-4}	70	6×10^{-5}
		Bone	90	200	2×10^{-4}	70	6×10^{-5}
		Skin	100	300	3×10^{-4}	100	10^{-4}
	(Insol)	**GI (ULI)**		**0.01**	**2×10^{-6}**	**4×10^{-3}**	**6×10^{-7}**
		Lung			2×10^{-5}		6×10^{-6}
$_{49}In^{115}$ (β^-)		**GI (LLI)**		**3×10^{-3}**	6×10^{-7}	**9×10^{-4}**	2×10^{-7}
		Kidney	30	0.3	**2×10^{-7}**	0.1	**9×10^{-8}**
		Spleen	40	0.4	3×10^{-7}	0.1	10^{-7}
	(Sol)	Liver	50	0.5	4×10^{-7}	0.1	10^{-7}
		Bone	60	0.6	5×10^{-7}	0.2	2×10^{-7}
		Skin	80	0.8	7×10^{-7}	0.3	2×10^{-7}
		Total Body	100	1	10^{-6}	0.4	3×10^{-7}
		Thyroid	3×10^3	30	2×10^{-5}	9	8×10^{-6}
	(Insol)	**Lung**			**3×10^{-8}**		**10^{-8}**
		GI (LLI)		**3×10^{-3}**	5×10^{-7}	**9×10^{-4}**	2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{50}Sn^{113}$ (ϵ, γ, e^-)	**GI (LLI)**		2×10^{-3}	5×10^{-7}	9×10^{-4}	2×10^{-7}
	Bone	30	0.02	4×10^{-7}	6×10^{-3}	10^{-7}
(Sol)	Total Body	60	0.04	8×10^{-7}	0.01	3×10^{-7}
(Sol)	Prostate	70	0.04	9×10^{-7}	0.02	3×10^{-7}
(Sol)	Liver	400	0.3	5×10^{-6}	0.09	2×10^{-6}
(Sol)	Thyroid	10^3	0.9	2×10^{-5}	0.3	6×10^{-6}
(Insol)	**Lung**			5×10^{-8}		2×10^{-8}
(Insol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	8×10^{-4}	10^{-7}
$_{50}Sn^{125}$ (β^-, γ, e^-)	**GI (LLI)**		5×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
	Bone	7	0.02	3×10^{-7}	6×10^{-3}	10^{-7}
(Sol)	Prostate	10	0.03	6×10^{-7}	9×10^{-3}	2×10^{-7}
(Sol)	Total Body	20	0.05	10^{-6}	0.02	4×10^{-7}
(Sol)	Liver	100	0.3	7×10^{-6}	0.1	2×10^{-6}
(Sol)	Thyroid	300	0.8	2×10^{-5}	0.3	5×10^{-6}
(Insol)	**Lung**			8×10^{-8}		3×10^{-8}
(Insol)	**GI (LLI)**		5×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
$_{51}Sb^{122}$ (β^-, γ)	**GI (LLI)**		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	Total Body	20	0.3	4×10^{-6}	0.1	10^{-6}
(Sol)	Lung	40	0.5	6×10^{-6}	0.2	2×10^{-6}
(Sol)	Bone	40	0.5	6×10^{-6}	0.2	2×10^{-6}
(Sol)	Liver	10^3	10	2×10^{-4}	4	5×10^{-5}
(Sol)	Thyroid	3×10^3	40	4×10^{-4}	10	2×10^{-4}

	(Insol)	**GI (LLI)**		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}
		Lung			4×10^{-7}		10^{-7}
$_{51}Sb^{124}$ (β^-, γ)	(Sol)	**GI (LLI)**		7×10^{-4}	2×10^{-7}	2×10^{-4}	5×10^{-8}
		Total Body	10	0.02	2×10^{-7}	6×10^{-3}	7×10^{-8}
		Lung	20	0.02	3×10^{-7}	8×10^{-3}	10^{-7}
		Bone	30	0.04	5×10^{-7}	0.01	2×10^{-7}
		Liver	800	1	10^{-5}	0.4	4×10^{-6}
		Thyroid	10^4	20	2×10^{-4}	6	7×10^{-5}
	(Insol)	**Lung**			2×10^{-8}		7×10^{-9}
		GI (LLI)		7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
$_{51}Sb^{125}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
		Lung	40	0.04	5×10^{-7}	0.01	2×10^{-7}
		Total Body	60	0.05	6×10^{-7}	0.02	2×10^{-7}
		Bone	70	0.06	8×10^{-7}	0.02	2×10^{-7}
		Liver	3×10^3	3	3×10^{-5}	0.9	10^{-5}
		Thyroid	7×10^4	60	7×10^{-4}	20	2×10^{-4}
	(Insol)	**Lung**			3×10^{-8}		9×10^{-9}
		GI (LLI)		3×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
$_{52}Te^{125m}$ (γ, e^-)	(Sol)	**Kidney**	29	5×10^{-3}	4×10^{-7}	2×10^{-3}	10^{-7}
		GI (LLI)		5×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		Testis	20	6×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
		Spleen	50	0.02	10^{-6}	6×10^{-3}	4×10^{-7}
		Liver	100	0.04	3×10^{-6}	0.01	9×10^{-7}
		Total Body	100	0.04	3×10^{-6}	0.01	10^{-6}
		Bone	100	0.04	3×10^{-6}	0.02	10^{-6}
		Thyroid	500	0.2	10^{-5}	0.05	4×10^{-6}
	(Insol)	**Lung**			10^{-7}		4×10^{-8}
		GI (LLI)		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{52}Te^{127m}$ (β^-, γ, e^-)	**Kidney**	7	$\mathbf{2\times10^{-3}}$	$\mathbf{10^{-7}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{5\times10^{-8}}$
	Testis	7	$\mathbf{2\times10^{-3}}$	$\mathbf{10^{-7}}$	7×10^{-4}	$\mathbf{5\times10^{-8}}$
	GI (LLI)	----------	$\mathbf{2\times10^{-3}}$	5×10^{-7}	8×10^{-4}	2×10^{-7}
(Sol)	Spleen	20	6×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
	Bone	50	0.01	9×10^{-7}	4×10^{-3}	3×10^{-7}
	Liver	50	0.01	10^{-6}	5×10^{-3}	4×10^{-7}
	Total Body	60	0.02	10^{-6}	6×10^{-3}	4×10^{-7}
	Thyroid	200	0.05	4×10^{-6}	0.02	10^{-6}
(Insol)	**Lung**	----------	----------	$\mathbf{4\times10^{-8}}$	----------	$\mathbf{10^{-8}}$
	GI (LLI)	----------	$\mathbf{2\times10^{-3}}$	3×10^{-7}	$\mathbf{5\times10^{-4}}$	9×10^{-8}
$_{52}Te^{127}$ (β^-)	**GI (LLI)**	----------	$\mathbf{8\times10^{-3}}$	$\mathbf{2\times10^{-6}}$	$\mathbf{3\times10^{-3}}$	$\mathbf{6\times10^{-7}}$
	Kidney	20	0.1	10^{-5}	0.05	4×10^{-6}
	Testis	20	0.2	10^{-5}	0.05	4×10^{-6}
(Sol)	Spleen	50	0.5	4×10^{-5}	0.2	10^{-5}
	Total Body	80	0.8	6×10^{-5}	0.3	2×10^{-5}
	Bone	100	1	7×10^{-5}	0.3	2×10^{-5}
	Liver	100	1	9×10^{-5}	0.4	3×10^{-5}
	Thyroid	100	1	10^{-4}	0.5	4×10^{-5}
(Insol)	**GI (LLI)**	----------	$\mathbf{5\times10^{-3}}$	$\mathbf{9\times10^{-7}}$	$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$
	Lung	----------	----------	8×10^{-6}	----------	3×10^{-6}

$_{52}Te^{129m}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**10^{-3}**	2×10^{-7}	3×10^{-4}	7×10^{-8}
		Kidney	3	**10^{-3}**	8×10^{-8}	4×10^{-4}	3×10^{-8}
		Testis	3	**10^{-3}**	9×10^{-8}	4×10^{-4}	3×10^{-8}
		Spleen	10	4×10^{-3}	3×10^{-7}	10^{-3}	9×10^{-8}
		Total Body	20	6×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
		Liver	20	8×10^{-3}	6×10^{-7}	3×10^{-3}	2×10^{-7}
		Bone	20	9×10^{-3}	6×10^{-7}	3×10^{-3}	2×10^{-7}
		Thyroid	70	0.03	2×10^{-6}	8×10^{-3}	6×10^{-7}
	(Insol)	**Lung**			**3×10^{-8}**		**10^{-8}**
		GI (LLI)		**6×10^{-4}**	10^{-7}	**2×10^{-4}**	4×10^{-8}
$_{52}Te^{129}$ (β^-, γ, e^-)	(Sol)	**GI (S)**		**0.02**	**5×10^{-6}**	**8×10^{-3}**	**2×10^{-6}**
		Kidney	5	0.4	3×10^{-5}	0.1	10^{-5}
		Testis	6	0.4	3×10^{-5}	0.2	10^{-5}
		Spleen	20	1	10^{-4}	0.5	3×10^{-5}
		Total Body	20	2	10^{-4}	0.5	4×10^{-5}
		Liver	40	3	2×10^{-4}	1	7×10^{-5}
		Bone	40	3	2×10^{-4}	1	8×10^{-5}
		Thyroid	60	4	3×10^{-4}	1	10^{-4}
	(Insol)	**GI (ULI)**		**0.02**	**4×10^{-6}**	**8×10^{-3}**	**10^{-6}**
		Lung			2×10^{-5}		7×10^{-6}
$_{52}Te^{131m}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**2×10^{-3}**	**4×10^{-7}**	**6×10^{-4}**	**10^{-7}**
		Kidney	4	0.01	10^{-6}	5×10^{-3}	3×10^{-7}
		Total Body	10	0.04	3×10^{-6}	0.01	10^{-6}
		Spleen	20	0.05	4×10^{-6}	0.02	10^{-6}
		Liver	30	0.09	7×10^{-6}	0.03	2×10^{-6}
		Bone	50	0.1	10^{-5}	0.05	4×10^{-6}
		Thyroid	50	0.2	10^{-5}	0.06	4×10^{-6}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**4×10^{-4}**	**6×10^{-8}**
		Lung			6×10^{-7}		2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{52}Te^{132}$ (β^-, γ, e^-)	**GI (LLI)**		9×10^{-4}	2×10^{-7}	3×10^{-4}	7×10^{-8}
(Sol)	Kidney	3	5×10^{-3}	4×10^{-7}	2×10^{-3}	10^{-7}
	Testis	5	7×10^{-3}	5×10^{-7}	2×10^{-3}	2×10^{-7}
	Total Body	10	0.02	10^{-6}	5×10^{-3}	4×10^{-7}
	Spleen	10	0.02	10^{-6}	6×10^{-3}	4×10^{-7}
	Liver	20	0.03	2×10^{-6}	0. 01	8×10^{-7}
	Bone	30	0.05	4×10^{-6}	0. 02	10^{-6}
	Thyroid	50	0.07	5×10^{-6}	0. 02	10^{-6}
(Insol)	**GI (LLI)**		6×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
	Lung			2×10^{-7}		7×10^{-8}
$_{53}I^{126}$ (β^-, ϵ, γ)	**Thyroid**	1	5×10^{-5}	8×10^{-9}	2×10^{-5}	3×10^{-9}
(Sol)	Total Body	90	6×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
	GI (LLI)		0.05	10^{-5}	0. 02	4×10^{-6}
(Insol)	**Lung**			3×10^{-7}		10^{-7}
	GI (LLI)		3×10^{-3}	5×10^{-7}	9×10^{-4}	2×10^{-7}
$_{53}I^{129}$ (β^-, γ, e^-)	**Thyroid**	3	10^{-5}	2×10^{-9}	4×10^{-6}	6×10^{-10}
(Sol)	Total Body	200	2×10^{-3}	2×10^{-7}	5×10^{-4}	7×10^{-8}
	GI (LLI)		0.1	3×10^{-5}	0. 04	9×10^{-6}
(Insol)	**Lung**			7×10^{-8}		2×10^{-8}
	GI (LLI)		6×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}

$_{53}I^{131}$ (β^-,γ,e^-)	(Sol)	**Thyroid**	0.7	6×10^{-5}	9×10^{-9}	2×10^{-5}	3×10^{-9}
		Total Body	50	5×10^{-3}	8×10^{-7}	2×10^{-3}	3×10^{-7}
		GI (LLI)		0.03	7×10^{-6}	0.01	2×10^{-6}
	(Insol)	**GI (LLI)**		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
		Lung			3×10^{-7}		10^{-7}
$_{53}I^{132}$ (β^-, γ, e^-)	(Sol)	**Thyroid**	0.3	2×10^{-3}	2×10^{-7}	6×10^{-4}	8×10^{-8}
		GI (SI)		0.01	3×10^{-6}	4×10^{-3}	9×10^{-7}
		Total Body	10	0.1	2×10^{-5}	0.04	6×10^{-6}
	(Insol)	**GI (ULI)**		5×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
		Lung			7×10^{-6}		2×10^{-6}
$_{53}I^{133}$ (β^-, γ, e^-)	(Sol)	**Thyroid**	0.3	2×10^{-4}	3×10^{-8}	7×10^{-5}	10^{-8}
		GI (SI)		0.02	4×10^{-6}	6×10^{-3}	10^{-6}
		Total Body	20	0.02	4×10^{-6}	9×10^{-3}	10^{-6}
	(Insol)	**GI (LLI)**		10^{-3}	2×10^{-7}	4×10^{-4}	7×10^{-8}
		Lung			10^{-6}		4×10^{-7}
$_{53}I^{134}$ (β^-, γ)	(Sol)	**Thyroid**	0.2	4×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
		GI (S)		0.02	4×10^{-6}	6×10^{-3}	10^{-6}
		Total Body	10	0.3	5×10^{-5}	0.1	2×10^{-5}
	(Insol)	**GI (S)**		**0.02**	3×10^{-6}	6×10^{-3}	10^{-6}
		Lung			2×10^{-5}		7×10^{-6}
$_{53}I^{135}$ (β^-, γ, e^-)	(Sol)	**Thyroid**	0.3	7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
		GI (SI)		0.01	3×10^{-6}	5×10^{-3}	10^{-6}
		Total Body	20	0.05	7×10^{-6}	0.02	3×10^{-6}
	(Insol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	7×10^{-4}	10^{-7}
		Lung			3×10^{-6}		10^{-6}
$_{54}Xe^{131m}$ (γ, e^-)	(Immersion)	**Total Body**			2×10^{-5}		4×10^{-6}
$_{54}Xe^{133}$ (γ, e^-)	(Immersion)	**Total Body**			10^{-5}		3×10^{-6}
$_{54}Xe^{135}$ (β^-, γ)	(Immersion)	**Total Body**			4×10^{-6}		10^{-6}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{55}Cs^{131}$ (ϵ)		**Total Body**	700	**0.07**	**10^{-5}**	**0.02**	**4×10^{-6}**
		Liver	800	0.09	**10^{-5}**	0.03	**4×10^{-6}**
		Spleen	10^3	0.1	2×10^{-5}	0.04	6×10^{-6}
	(Sol)	Kidney	10^3	0.1	2×10^{-5}	0.05	7×10^{-6}
		Muscle	2×10^3	0.2	3×10^{-5}	0.07	10^{-5}
		GI (SI)		0.5	10^{-4}	0.2	4×10^{-5}
		Bone	8×10^3	0.9	10^{-4}	0.3	4×10^{-5}
		Lung	10^4	1	2×10^{-4}	0.4	5×10^{-5}
	(Insol)	**Lung**			**3×10^{-6}**		**10^{-6}**
		GI (LLI)		**0.03**	5×10^{-6}	**9×10^{-3}**	2×10^{-6}
$_{55}Cs^{134m}$ (β^-, γ, e^-)		**GI (S)**		**0.2**	**4×10^{-5}**	**0.06**	**10^{-5}**
		Total Body	100	0.7	10^{-4}	0.3	4×10^{-5}
		Liver	100	1	10^{-4}	0.3	5×10^{-5}
	(Sol)	Spleen	200	1	2×10^{-4}	0.5	7×10^{-5}
		Kidney	200	2	2×10^{-4}	0.6	8×10^{-5}
		Muscle	200	2	2×10^{-4}	0.6	9×10^{-5}
		Bone	600	4	6×10^{-4}	1	2×10^{-4}
		Lung	2×10^3	10	2×10^{-3}	4	6×10^{-4}
	(Insol)	**GI (ULI)**		**0.03**	**6×10^{-6}**	**0.01**	**2×10^{-6}**
		Lung			3×10^{-5}		10^{-5}

$_{55}Cs^{134}$ (β^-, γ)	(Sol)	**Total Body**	20	$\mathbf{3\times10^{-4}}$	$\mathbf{4\times10^{-8}}$	$\mathbf{9\times10^{-5}}$	$\mathbf{10^{-8}}$
		Liver	30	4×10^{-4}	6×10^{-8}	10^{-4}	2×10^{-8}
		Muscle	30	4×10^{-4}	6×10^{-8}	2×10^{-4}	2×10^{-8}
		Spleen	40	6×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
		Kidney	90	10^{-3}	2×10^{-7}	4×10^{-4}	6×10^{-8}
		Bone	200	2×10^{-3}	3×10^{-7}	7×10^{-4}	10^{-7}
		Lung	300	4×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
		GI (SI)	----------	0.01	3×10^{-6}	5×10^{-3}	10^{-6}
	(Insol)	**Lung**	----------	----------	$\mathbf{10^{-8}}$	----------	$\mathbf{4\times10^{-9}}$
		GI (LLI)	----------	$\mathbf{10^{-3}}$	2×10^{-7}	$\mathbf{4\times10^{-4}}$	7×10^{-8}
$_{55}Cs^{135}$ (β^-)	(Sol)	**Liver**	200	$\mathbf{3\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Spleen	300	4×10^{-3}	$\mathbf{5\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Total Body	300	4×10^{-3}	6×10^{-7}	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$
		Bone	400	6×10^{-3}	8×10^{-7}	2×10^{-3}	3×10^{-7}
		Muscle	500	6×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
		Kidney	600	9×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
		Lung	2×10^3	0.03	4×10^{-6}	0.01	10^{-6}
		GI (LLI)	----------	0.1	3×10^{-5}	0.05	10^{-5}
	(Insol)	**GI (LLI)**	----------	$\mathbf{7\times10^{-3}}$	10^{-6}	$\mathbf{2\times10^{-3}}$	4×10^{-7}
		Lung	----------	----------	$\mathbf{9\times10^{-8}}$	----------	$\mathbf{3\times10^{-8}}$
$_{55}Cs^{136}$ (β^-, γ)	(Sol)	**Total Body**	30	$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$	$\mathbf{9\times10^{-4}}$	$\mathbf{10^{-7}}$
		Liver	60	5×10^{-3}	7×10^{-7}	2×10^{-3}	2×10^{-7}
		Spleen	80	7×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		Muscle	90	8×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
		Kidney	100	8×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
		GI (SI)	----------	0.02	5×10^{-6}	8×10^{-3}	2×10^{-6}
		Bone	400	0.03	4×10^{-6}	0.01	2×10^{-6}
		Lung	800	0.06	9×10^{-6}	0.02	3×10^{-6}
	(Insol)	**Lung**	----------	----------	$\mathbf{2\times10^{-7}}$	----------	$\mathbf{6\times10^{-8}}$
		GI (LLI)	----------	$\mathbf{2\times10^{-3}}$	3×10^{-7}	$\mathbf{6\times10^{-4}}$	10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{55}Cs^{137}$ (β^-, γ, e^-)						
(Sol)	**Total Body**	30	4×10^{-4}	6×10^{-8}	2×10^{-4}	2×10^{-8}
	Liver	40	5×10^{-4}	8×10^{-8}	2×10^{-4}	3×10^{-8}
	Spleen	50	6×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
	Muscle	50	7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
	Bone	100	10^{-3}	2×10^{-7}	5×10^{-4}	7×10^{-8}
	Kidney	100	10^{-3}	2×10^{-7}	5×10^{-4}	8×10^{-8}
	Lung	300	5×10^{-3}	6×10^{-7}	2×10^{-3}	2×10^{-7}
	GI (SI)	----------	0.02	5×10^{-6}	8×10^{-3}	2×10^{-6}
(Insol)	**Lung**	----------	----------	10^{-8}	----------	5×10^{-9}
	GI (LLI)	----------	10^{-3}	2×10^{-7}	4×10^{-4}	8×10^{-8}
$_{56}Ba^{131}$ (ϵ, γ)						
	GI (LLI)	----------	5×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
(Sol)	Total Body	50	0.1	2×10^{-6}	0.03	7×10^{-7}
	Bone	80	0.1	3×10^{-6}	0.05	10^{-6}
	Liver	10^4	20	4×10^{-4}	7	10^{-4}
	Muscle	2×10^4	40	7×10^{-4}	10	2×10^{-4}
	Lung	2×10^4	40	7×10^{-4}	10	2×10^{-4}
	Spleen	3×10^4	60	10^{-3}	20	4×10^{-4}
	Kidney	4×10^4	70	10^{-3}	20	5×10^{-4}
(Insol)	**Lung**	----------	----------	4×10^{-7}	----------	10^{-7}
	GI (LLI)	----------	5×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}

$_{56}Ba^{140}$ (β^-, γ)		**GI (LLI)**		$\mathbf{8\times10^{-4}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{6\times10^{-8}}$
		Bone	4	$\mathbf{6\times10^{-3}}$	$\mathbf{10^{-7}}$	$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-8}}$
		Total Body	9	0.01	3×10^{-7}	5×10^{-3}	10^{-7}
	(Sol)	Liver	10^3	2	5×10^{-5}	0. 9	2×10^{-5}
		Lung	3×10^3	4	9×10^{-5}	2	3×10^{-5}
		Muscle	3×10^3	5	10^{-4}	2	4×10^{-5}
		Spleen	4×10^3	6	10^{-4}	2	4×10^{-5}
		Kidney	4×10^3	8	2×10^{-4}	3	5×10^{-5}
	(Insol)	**Lung**			$\mathbf{4\times10^{-8}}$		$\mathbf{10^{-8}}$
		GI (LLI)		$\mathbf{7\times10^{-4}}$	10^{-7}	$\mathbf{2\times10^{-4}}$	4×10^{-8}
$_{57}La^{140}$ (β^-, γ)		**GI (LLI)**		$\mathbf{7\times10^{-4}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{2\times10^{-4}}$	$\mathbf{5\times10^{-8}}$
	(Sol)	Liver	9	50	2×10^{-6}	20	7×10^{-7}
		Bone	10	60	2×10^{-6}	20	8×10^{-7}
		Total Body	10	60	2×10^{-6}	20	9×10^{-7}
	(Insol)	**GI (LLI)**		$\mathbf{7\times10^{-4}}$	$\mathbf{10^{-7}}$	$\mathbf{2\times10^{-4}}$	$\mathbf{4\times10^{-8}}$
		Lung			4×10^{-7}		10^{-7}
$_{58}Ce^{141}$ (β^-, γ)		**GI (LLI)**		$\mathbf{3\times10^{-3}}$	6×10^{-7}	$\mathbf{9\times10^{-4}}$	$\mathbf{2\times10^{-7}}$
		Liver	30	10	4×10^{-7}	3	$\mathbf{2\times10^{-7}}$
	(Sol)	**Bone**	40	10	6×10^{-7}	5	$\mathbf{2\times10^{-7}}$
		Kidney	70	20	9×10^{-7}	7	3×10^{-7}
		Total Body	90	30	10^{-6}	10	4×10^{-7}
	(Insol)	**Lung**			$\mathbf{2\times10^{-7}}$		$\mathbf{5\times10^{-8}}$
		GI (LLI)		$\mathbf{3\times10^{-3}}$	5×10^{-7}	$\mathbf{9\times10^{-4}}$	2×10^{-7}
$_{58}Ce^{143}$ (β^-, γ)		**GI (LLI)**		$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{9\times10^{-8}}$
		Liver	7	50	2×10^{-6}	20	7×10^{-7}
	(Sol)	Bone	10	70	3×10^{-6}	20	10^{-6}
		Kidney	20	100	5×10^{-6}	40	2×10^{-6}
		Total Body	20	100	6×10^{-6}	50	2×10^{-6}
	(Insol)	**GI (LLI)**		$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{7\times10^{-8}}$
		Lung			6×10^{-7}		2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{58}Ce^{144}$ $(\alpha, \beta^-, \gamma)$						
	GI (LLI)		$\mathbf{3\times10^{-4}}$	8×10^{-8}	$\mathbf{10^{-4}}$	3×10^{-8}
	Bone	5	0.2	$\mathbf{10^{-8}}$	0.08	$\mathbf{3\times10^{-9}}$
(Sol)	**Liver**	6	0.3	$\mathbf{10^{-8}}$	0.1	4×10^{-9}
	Kidney	10	0.5	2×10^{-8}	0.2	7×10^{-9}
	Total Body	20	0.7	3×10^{-8}	0.3	10^{-8}
	Lung			$\mathbf{6\times10^{-9}}$		$\mathbf{2\times10^{-9}}$
(Insol)	**GI (LLI)**		$\mathbf{3\times10^{-4}}$	6×10^{-8}	$\mathbf{10^{-4}}$	2×10^{-8}
$_{59}Pr^{142}$ (β^-, γ)						
	GI (LLI)		$\mathbf{9\times10^{-4}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{7\times10^{-8}}$
	Bone	7	80	4×10^{-6}	30	10^{-6}
(Sol)	Liver	9	100	4×10^{-6}	40	2×10^{-6}
	Kidney	20	200	8×10^{-6}	60	3×10^{-6}
	Total Body	20	300	10^{-5}	90	4×10^{-6}
	GI (LLI)		$\mathbf{9\times10^{-4}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{5\times10^{-8}}$
(Insol)	Lung			10^{-6}		4×10^{-7}
$_{59}Pr^{143}$ (β^-)						
	GI (LLI)		$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{5\times10^{-4}}$	$\mathbf{10^{-7}}$
	Bone	20	10	5×10^{-7}	4	2×10^{-7}
(Sol)	Liver	20	20	7×10^{-7}	5	2×10^{-7}
	Kidney	40	30	10^{-6}	9	4×10^{-7}
	Total Body	60	40	2×10^{-6}	10	6×10^{-7}

	(Insol)	**Lung**			2×10^{-7}		6×10^{-8}
		GI (LLI)		10^{-3}	3×10^{-7}	5×10^{-4}	9×10^{-8}
$_{60}Nd^{144}$ (α)		**Bone**	0.1	2×10^{-3}	8×10^{-11}	7×10^{-4}	3×10^{-11}
		GI (LLI)		2×10^{-3}	5×10^{-7}	8×10^{-4}	2×10^{-7}
	(Sol)	Kidney	0.3	4×10^{-3}	2×10^{-10}	10^{-3}	5×10^{-11}
		Liver	0.7	0.01	4×10^{-10}	3×10^{-3}	2×10^{-10}
		Total Body	1	0.01	6×10^{-10}	5×10^{-3}	2×10^{-10}
	(Insol)	**Lung**			3×10^{-10}		10^{-10}
		GI (LLI)		2×10^{-3}	4×10^{-7}	8×10^{-4}	10^{-7}
$_{60}Nd^{147}$ (α, β^-, γ)		**GI (LLI)**		2×10^{-3}	4×10^{-7}	6×10^{-4}	10^{-7}
		Liver	10	8	4×10^{-7}	3	10^{-7}
	(Sol)	Kidney	20	10	6×10^{-7}	5	2×10^{-7}
		Bone	20	20	8×10^{-7}	6	3×10^{-7}
		Total Body	50	40	2×10^{-6}	10	6×10^{-7}
	(Insol)	**Lung**			2×10^{-7}		8×10^{-8}
		GI (LLI)		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
$_{60}Nd^{149}$(β^-, γ)		**GI (LLI)**		8×10^{-3}	2×10^{-6}	3×10^{-3}	6×10^{-7}
		Liver	3	300	10^{-5}	100	5×10^{-6}
	Sol)	Kidney	5	600	3×10^{-5}	200	9×10^{-6}
		Bone	7	700	3×10^{-5}	300	10^{-5}
		Total Body	20	2×10^{3}	9×10^{-5}	700	3×10^{-5}
	(Insol)	**GI (ULI)**		8×10^{-3}	10^{-6}	3×10^{-3}	5×10^{-7}
		Lung			9×10^{-6}		3×10^{-6}
$_{61}Pm^{147}$(α, β^-)		**GI (LLI)**		6×10^{-3}	10^{-6}	2×10^{-3}	5×10^{-7}
		Bone	60	1	6×10^{-8}	0.5	2×10^{-8}
	(Sol)	Kidney	200	4	2×10^{-7}	2	7×10^{-8}
		Total Body	300	7	3×10^{-7}	2	10^{-7}
		Liver	300	8	4×10^{-7}	3	10^{-7}
	(Insol)	**Lung**			10^{-7}		3×10^{-8}
		GI (LLI)		6×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{61}Pm^{149}(\beta^-, \gamma)$	**GI (LLI)**	----------	$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{10^{-7}}$
(Sol)	Bone	20	70	3×10^{-6}	20	10^{-6}
	Kidney	30	100	6×10^{-6}	40	2×10^{-6}
	Total Body	40	200	7×10^{-6}	50	2×10^{-6}
	Liver	50	200	10^{-5}	80	3×10^{-6}
(Insol)	**GI (LLI)**	----------	$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{4\times10^{-4}}$	$\mathbf{8\times10^{-8}}$
	Lung	----------	----------	7×10^{-7}	----------	3×10^{-7}
$_{62}Sm^{147}(\alpha)$	**Bone**	0.1	$\mathbf{2\times10^{-3}}$	$\mathbf{7\times10^{-11}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{2\times10^{-11}}$
	GI (LLI)	----------	$\mathbf{2\times10^{-3}}$	4×10^{-7}	7×10^{-4}	2×10^{-7}
(Sol)	Kidney	0.6	8×10^{-3}	4×10^{-10}	3×10^{-3}	10^{-10}
	Liver	0.6	9×10^{-3}	4×10^{-10}	3×10^{-3}	10^{-10}
	Total Body	0.9	0.01	5×10^{-10}	4×10^{-3}	2×10^{-10}
(Insol)	**Lung**	----------	----------	$\mathbf{3\times10^{-10}}$	----------	$\mathbf{9\times10^{-11}}$
	GI (LLI)	----------	$\mathbf{2\times10^{-3}}$	4×10^{-7}	$\mathbf{7\times10^{-4}}$	10^{-7}
$_{62}Sm^{151}$ (β^-, γ)	**GI (LLI)**	----------	**0.01**	2×10^{-6}	$\mathbf{4\times10^{-3}}$	8×10^{-7}
	Bone	100	2	$\mathbf{6\times10^{-8}}$	0.5	$\mathbf{2\times10^{-8}}$
(Sol)	Kidney	300	4	2×10^{-7}	2	6×10^{-8}
	Liver	300	5	2×10^{-7}	2	7×10^{-8}
	Total Body	500	7	3×10^{-7}	2	10^{-7}

	(Insol)	**Lung**			10^{-7}		5×10^{-8}
		GI (LLI)		0.01	2×10^{-6}	4×10^{-3}	7×10^{-7}
$_{62}Sm^{153}$ (β^-, γ)		**GI (LLI)**		2×10^{-3}	5×10^{-7}	8×10^{-4}	2×10^{-7}
	(Sol)	Liver	20	70	3×10^{-6}	30	10^{-6}
		Bone	30	100	6×10^{-6}	50	2×10^{-6}
		Kidney	50	200	10^{-5}	80	4×10^{-6}
		Total Body	70	300	10^{-5}	100	5×10^{-6}
	(Insol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	8×10^{-4}	10^{-7}
		Lung			10^{-6}		5×10^{-7}
$_{63}Eu^{152}$ (9.2 hr) (β^-, ϵ, γ)		**GI (LLI)**		2×10^{-3}	4×10^{-7}	6×10^{-4}	10^{-7}
	(Sol)	Liver	8	200	9×10^{-6}	70	3×10^{-6}
		Bone	10	300	10^{-5}	90	4×10^{-6}
		Kidney	10	300	10^{-5}	100	5×10^{-6}
		Total Body	20	500	2×10^{-5}	200	8×10^{-6}
	(Insol)	**GI (LLI)**		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
		Lung			3×10^{-6}		9×10^{-7}
$_{63}Eu^{152}$(13 yr)(β^-, ϵ, γ)		**GI (LLI)**		2×10^{-3}	5×10^{-7}	8×10^{-4}	2×10^{-7}
	(Sol)	**Kidney**	20	0.3	10^{-8}	0.09	4×10^{-9}
		Total Body	30	0.5	2×10^{-8}	0.2	7×10^{-9}
		Bone	30	0.6	3×10^{-8}	0.2	8×10^{-9}
		Liver	80	1.0	6×10^{-8}	0.4	2×10^{-8}
	(Insol)	**Lung**			2×10^{-8}		6×10^{-9}
		GI (LLI)		2×10^{-3}	4×10^{-7}	8×10^{-4}	10^{-7}
$_{63}Eu^{154}$(β^-, ϵ, γ)		**GI (LLI)**		6×10^{-4}	10^{-7}	2×10^{-4}	5×10^{-8}
	(Sol)	**Kidney**	5	0.09	4×10^{-9}	0.03	10^{-9}
		Bone	5	0.09	4×10^{-9}	0.03	10^{-9}
		Total Body	20	0.2	10^{-8}	0.08	4×10^{-9}
		Liver	30	0.5	2×10^{-8}	0.2	7×10^{-9}
	(Insol)	**Lung**			7×10^{-9}		2×10^{-9}
		GI (LLI)		6×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{63}Eu^{155}(\beta^-, \gamma)$		**GI (LLI)**		$\mathbf{6\times10^{-3}}$	10^{-6}	$\mathbf{2\times10^{-3}}$	4×10^{-7}
	(Sol)	**Kidney**	70	2	$\mathbf{9\times10^{-8}}$	0.7	$\mathbf{3\times10^{-8}}$
		Bone	80	2	10^{-7}	0.8	$\mathbf{3\times10^{-8}}$
		Total Body	100	4	2×10^{-7}	1	5×10^{-8}
		Liver	200	5	2×10^{-7}	2	8×10^{-8}
	(Insol)	**Lung**			$\mathbf{7\times10^{-8}}$		$\mathbf{3\times10^{-8}}$
		GI (LLI)		$\mathbf{6\times10^{-3}}$	10^{-6}	$\mathbf{2\times10^{-3}}$	4×10^{-7}
$_{64}Gd^{153}(\epsilon, \gamma, e^-)$		**GI (LLI)**		$\mathbf{6\times10^{-3}}$	10^{-6}	$\mathbf{2\times10^{-3}}$	5×10^{-7}
	(Sol)	**Bone**	90	5	$\mathbf{2\times10^{-7}}$	2	$\mathbf{8\times10^{-8}}$
		Total Body	100	7	3×10^{-7}	2	10^{-7}
		Liver	100	7	3×10^{-7}	2	10^{-7}
	(Insol)	**Lung**			$\mathbf{9\times10^{-8}}$		$\mathbf{3\times10^{-8}}$
		GI (LLI)		$\mathbf{6\times10^{-3}}$	10^{-6}	$\mathbf{2\times10^{-3}}$	4×10^{-7}
$_{64}Gd^{159}$ (β^-, γ)		**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{8\times10^{-4}}$	$\mathbf{2\times10^{-7}}$
	(Sol)	Bone	20	200	9×10^{-6}	70	3×10^{-6}
		Liver	40	400	2×10^{-5}	200	7×10^{-6}
		Total Body	50	700	3×10^{-5}	200	10^{-5}
	(Insol)	**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$	$\mathbf{8\times10^{-4}}$	$\mathbf{10^{-7}}$
		Lung			3×10^{-6}		10^{-6}

$_{65}Tb^{160}$ (β^-, γ)	(Sol)	**GI (LLI)**		**10^{-3}**	**3×10^{-7}**	**4×10^{-4}**	10^{-7}
		Bone	20	2	**10^{-7}**	0.8	**3×10^{-8}**
		Kidney	20	3	**10^{-7}**	1	4×10^{-8}
		Total Body	20	3	**10^{-7}**	1	5×10^{-8}
	(Insol)	**Lung**			**3×10^{-8}**		**10^{-8}**
		GI (LLI)		**10^{-3}**	2×10^{-7}	**4×10^{-4}**	8×10^{-8}
$_{66}Dy^{165}$ (β^-, γ)	(Sol)	**GI (LLI)**		**0.01**	**3×10^{-6}**	**4×10^{-3}**	**9×10^{-7}**
		Bone	10	10^3	5×10^{-5}	400	2×10^{-5}
		Total Body	40	4×10^3	2×10^{-4}	10^3	6×10^{-5}
		Liver	60	6×10^3	3×10^{-4}	2×10^3	9×10^{-5}
	(Insol)	**GI (ULI)**		**0.01**	**2×10^{-6}**	**4×10^{-3}**	**7×10^{-7}**
		Lung			2×10^{-5}		6×10^{-6}
$_{66}Dy^{166}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**4×10^{-4}**	**8×10^{-8}**
		Bone	5	10	6×10^{-7}	4	2×10^{-7}
		Total Body	30	70	3×10^{-6}	20	10^{-6}
		Liver	30	80	4×10^{-6}	30	10^{-6}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**4×10^{-4}**	**7×10^{-8}**
		Lung			3×10^{-7}		10^{-7}
$_{67}Ho^{166}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**9×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**7×10^{-8}**
		Bone	5	40	2×10^{-6}	10	6×10^{-7}
		Kidney	20	200	7×10^{-6}	50	2×10^{-6}
		Total Body	30	200	10^{-6}	80	4×10^{-7}
		Liver	40	300	10^{-5}	100	4×10^{-6}
	(Insol)	**GI (LLI)**		**9×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**6×10^{-8}**
		Lung			10^{-6}		3×10^{-7}
$_{68}Er^{169}$ (β^-, γ)	(Sol)	**GI (LLI)**		**3×10^{-3}**	**6×10^{-7}**	**9×10^{-4}**	**2×10^{-7}**
		Bone	30	30	10^{-6}	10	5×10^{-7}
		Total Body	50	50	2×10^{-6}	20	8×10^{-7}
		Kidney	70	60	3×10^{-6}	20	10^{-6}
		Liver	200	200	9×10^{-6}	70	3×10^{-6}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
	(Insol)	**Lung**			4×10^{-7}		10^{-7}
		GI (LLI)		3×10^{-3}	6×10^{-7}	9×10^{-4}	2×10^{-7}
$_{68}Er^{171}$ (β^-, γ, e^-)		**GI (ULI)**		3×10^{-3}	7×10^{-7}	10^{-3}	2×10^{-7}
	(Sol)	Bone	9	300	10^{-5}	90	4×10^{-6}
		Kidney	30	800	4×10^{-5}	300	10^{-5}
		Total Body	30	900	4×10^{-5}	300	10^{-5}
	(Insol)	**GI (ULI)**		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
		Lung			5×10^{-6}		2×10^{-6}
$_{69}Tm^{170}$ (β^-, ϵ, γ, e^-)		**GI (LLI)**		10^{-3}	3×10^{-7}	5×10^{-4}	10^{-7}
	(Sol)	**Bone**	9	0.8	4×10^{-8}	0.3	10^{-8}
		Kidney	30	4	2×10^{-7}	1	6×10^{-8}
		Total Body	60	5	2×10^{-7}	2	7×10^{-8}
	(Insol)	**Lung**			3×10^{-8}		10^{-8}
		GI (LLI)		10^{-3}	2×10^{-7}	5×10^{-4}	8×10^{-8}
$_{69}Tm^{171}$ (β^-)		**GI (LLI)**		0.01	3×10^{-6}	5×10^{-3}	10^{-6}
	(Sol)	**Bone**	90	3	10^{-7}	0.9	4×10^{-8}
		Kidney	700	20	8×10^{-7}	6	3×10^{-7}
		Total Body	700	20	8×10^{-7}	6	3×10^{-7}

	(Insol)	**Lung**			2×10^{-7}		8×10^{-8}
		GI (LLI)		**0.01**	3×10^{-6}	5×10^{-3}	9×10^{-7}
$_{70}Yb^{175}$ (β^-, γ)	(Sol)	**GI (LLI)**		3×10^{-3}	7×10^{-7}	10^{-3}	2×10^{-7}
		Bone	30	60	3×10^{-6}	20	9×10^{-7}
		Kidney	30	80	3×10^{-6}	30	10^{-6}
		Total Body	100	300	10^{-5}	100	4×10^{-6}
	(Insol)	**GI (LLI)**		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
		Lung			10^{-6}		4×10^{-7}
$_{71}Lu^{177}$ (β^-, γ)	(Sol)	**GI (LLI)**		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
		Bone	20	30	10^{-6}	10	4×10^{-7}
		Total Body	100	200	7×10^{-6}	60	2×10^{-6}
		Kidney	200	200	10^{-5}	80	3×10^{-6}
	(Insol)	**GI (LLI)**		3×10^{-3}	5×10^{-7}	10^{-3}	2×10^{-7}
		Lung			7×10^{-7}		2×10^{-7}
$_{72}Hf^{181}$ (β^-, γ)	(Sol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	7×10^{-4}	2×10^{-7}
		Spleen	4	0.9	4×10^{-8}	0.3	10^{-8}
		Liver	10	2	10^{-7}	0.8	4×10^{-8}
		Total Body	40	9	4×10^{-7}	3	10^{-7}
		Kidney	50	10	5×10^{-7}	4	2×10^{-7}
		Bone	100	20	9×10^{-7}	7	3×10^{-7}
	(Insol)	**Lung**			7×10^{-8}		3×10^{-8}
		GI (LLI)		2×10^{-3}	4×10^{-7}	7×10^{-4}	10^{-7}
$_{73}Ta^{182}$ (β^-, γ)	(Sol)	**GI (LLI)**		10^{-3}	3×10^{-7}	4×10^{-4}	9×10^{-8}
		Liver	7	0.9	4×10^{-8}	0.3	10^{-8}
		Kidney	20	2	8×10^{-8}	0.7	3×10^{-8}
		Total Body	20	2	9×10^{-8}	0.7	3×10^{-8}
		Spleen	30	4	10^{-7}	1	5×10^{-8}
		Bone	50	6	3×10^{-7}	2	9×10^{-8}
	(Insol)	**Lung**			2×10^{-8}		7×10^{-9}
		GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	7×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{74}W^{181}$ (ϵ, γ)	(Sol)	**GI (LLI)**		**0.01**	2×10^{-6}	4×10^{-3}	8×10^{-7}
		Liver	70	0.6	2×10^{-5}	0.2	8×10^{-6}
		Total Body	100	0.9	3×10^{-5}	0.3	10^{-5}
		Bone	200	2	7×10^{-5}	0.7	2×10^{-5}
	(Insol)	**Lung**			10^{-7}		4×10^{-8}
		GI (LLI)		**0.01**	2×10^{-6}	3×10^{-3}	6×10^{-7}
$_{74}W^{185}$ (β^-)	(Sol)	**GI (LLI)**		4×10^{-3}	8×10^{-7}	10^{-3}	3×10^{-7}
		Bone	30	0.3	10^{-5}	0.09	3×10^{-6}
		Liver	40	0.4	2×10^{-5}	0.1	5×10^{-6}
		Total Body	100	1	5×10^{-5}	0.5	2×10^{-5}
	(Insol)	**Lung**			10^{-7}		4×10^{-8}
		GI (LLI)		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
$_{74}W^{187}$ (β^-, γ)	(Sol)	**GI (LLI)**		2×10^{-3}	4×10^{-7}	7×10^{-4}	2×10^{-7}
		Total Body	30	0.5	2×10^{-5}	0.2	7×10^{-6}
		Liver	30	0.6	2×10^{-5}	0.2	8×10^{-6}
		Bone	60	1	4×10^{-5}	0.4	10^{-5}
	(Insol)	**GI (LLI)**		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
		Lung			2×10^{-6}		6×10^{-7}

$_{75}Re^{183}$ (ϵ, γ)		**GI (LLI)**		**0.02**	4×10^{-6}	**6×10^{-3}**	10^{-6}
		Total Body	80	**0.02**	**3×10^{-6}**	8×10^{-3}	**9×10^{-7}**
	(Sol)	Thyroid	300	0.09	10^{-5}	0.03	3×10^{-6}
		Liver	800	0.2	3×10^{-5}	0.08	8×10^{-6}
		Skin	4×10^{3}	1	10^{-4}	0.4	4×10^{-5}
		Bone	2×10^{4}	6	6×10^{-4}	2	2×10^{-4}
	(Insol)	**Lung**			**2×10^{-7}**		**5×10^{-8}**
		GI (LLI)		**8×10^{-3}**	10^{-6}	**3×10^{-3}**	5×10^{-7}
$_{75}Re^{186}$ (β^-, γ)		**GI (LLI)**		**3×10^{-3}**	**6×10^{-7}**	**9×10^{-4}**	**2×10^{-7}**
		Thyroid	20	0.01	2×10^{-6}	5×10^{-3}	5×10^{-7}
		Skin	30	0.02	2×10^{-6}	7×10^{-3}	8×10^{-7}
	(Sol)	Total Body	50	0.04	4×10^{-6}	0.01	10^{-6}
		Liver	300	0.2	3×10^{-5}	0.08	9×10^{-6}
		Bone	800	0.6	7×10^{-5}	0.2	2×10^{-5}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**5×10^{-4}**	**8×10^{-8}**
		Lung			5×10^{-7}		2×10^{-7}
$_{75}Re^{187}$ (β^-)		**GI (LLI)**		**0.07**	2×10^{-5}	**0.03**	6×10^{-6}
		Skin	300	0.08	**9×10^{-6}**	**0.03**	**3×10^{-6}**
		Thyroid	900	0.2	3×10^{-5}	0.08	9×10^{-6}
	(Sol)	Total Body	**2×10^{3}**	0.4	5×10^{-5}	0.2	2×10^{-5}
		Liver	6×10^{3}	2	2×10^{-4}	0.5	6×10^{-5}
		Bone	4×10^{4}	9	10^{-3}	3	4×10^{-4}
	(Insol)	**Lung**			**5×10^{-7}**		**2×10^{-7}**
		GI (LLI)		**0.04**	7×10^{-6}	**0.02**	2×10^{-6}
$_{75}Re^{188}$ (β^-, γ)		**GI (LLI)**		**2×10^{-3}**	**4×10^{-7}**	**6×10^{-4}**	**10^{-7}**
		Thyroid	7	0.02	2×10^{-6}	7×10^{-3}	7×10^{-7}
		Skin	20	0.05	5×10^{-6}	0.02	2×10^{-6}
	(Sol)	Total Body	20	0.06	7×10^{-6}	0.02	2×10^{-6}
		Liver	200	0.5	5×10^{-5}	0.2	2×10^{-5}
		Bone	300	0.9	10^{-4}	0.3	3×10^{-5}
	(Insol)	**GI (LLI)**		**9×10^{-4}**	**2×10^{-7}**	**3×10^{-4}**	**6×10^{-8}**
		Lung			10^{-6}		4×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{76}Os^{185}$ (ϵ, γ, e^-)	(Sol)	**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{5\times10^{-7}}$	$\mathbf{7\times10^{-4}}$	$\mathbf{2\times10^{-7}}$
		Kidney	8	0.04	10^{-6}	0.01	5×10^{-7}
		Total Body	40	0.2	6×10^{-6}	0.06	2×10^{-6}
		Liver	50	0.2	8×10^{-6}	0.08	3×10^{-6}
	(Insol)	**Lung**			$\mathbf{5\times10^{-8}}$		$\mathbf{2\times10^{-8}}$
		GI (LLI)		$\mathbf{2\times10^{-3}}$	3×10^{-7}	$\mathbf{7\times10^{-4}}$	10^{-7}
$_{76}Os^{191m}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		**0.07**	$\mathbf{2\times10^{-5}}$	**0.03**	$\mathbf{6\times10^{-6}}$
		Kidney	100	2	8×10^{-5}	0.8	3×10^{-5}
		Total Body	300	7	2×10^{-4}	2	8×10^{-5}
		Liver	600	10	5×10^{-4}	4	2×10^{-4}
	(Insol)	**Lung**			$\mathbf{9\times10^{-6}}$		$\mathbf{3\times10^{-6}}$
		GI (LLI)		**0.07**	10^{-5}	**0.02**	4×10^{-6}
$_{76}Os^{191}$ (β^-, γ, e^-)	(Sol)	**GI (LLI)**		$\mathbf{5\times10^{-3}}$	$\mathbf{10^{-6}}$	$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$
		Kidney	20	0.1	4×10^{-6}	0.04	10^{-6}
		Total Body	100	0.6	4×10^{-5}	0.2	8×10^{-6}
		Liver	100	0.7	3×10^{-5}	0.2	9×10^{-6}
	(Insol)	**Lung**			$\mathbf{4\times10^{-7}}$		$\mathbf{10^{-7}}$
		GI (LLI)		$\mathbf{5\times10^{-3}}$	8×10^{-7}	$\mathbf{2\times10^{-3}}$	3×10^{-7}

$_{76}Os^{193}$ (β^-)		**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{10^{-7}}$
	(Sol)	Kidney	10	0.1	4×10^{-6}	0.04	2×10^{-6}
		Total Body	50	0.6	2×10^{-5}	0.2	7×10^{-6}
		Liver	70	0.9	3×10^{-5}	0.3	10^{-5}
	(Insol)	**GI (LLI)**		$\mathbf{2\times10^{-3}}$	$\mathbf{3\times10^{-7}}$	$\mathbf{5\times10^{-4}}$	$\mathbf{9\times10^{-8}}$
		Lung			10^{-6}		5×10^{-7}
$_{77}Ir^{190}$ (ϵ, γ)		**GI (LLI)**		$\mathbf{6\times10^{-3}}$	$\mathbf{10^{-6}}$	$\mathbf{2\times10^{-3}}$	$\mathbf{4\times10^{-7}}$
	(Sol)	Liver	40	0.04	2×10^{-6}	0.02	5×10^{-7}
		Kidney	40	0.04	2×10^{-6}	0.02	6×10^{-7}
		Spleen	40	0.05	2×10^{-6}	0.02	6×10^{-7}
		Total Body	50	0.06	2×10^{-6}	0.02	8×10^{-7}
	(Insol)	**Lung**			$\mathbf{4\times10^{-7}}$		$\mathbf{10^{-7}}$
		GI (LLI)		$\mathbf{5\times10^{-3}}$	9×10^{-7}	$\mathbf{2\times10^{-3}}$	3×10^{-7}
$_{77}Ir^{192}$ (β^-, γ)		**GI (LLI)**		$\mathbf{10^{-3}}$	3×10^{-7}	$\mathbf{4\times10^{-4}}$	9×10^{-8}
	(Sol)	**Kidney**	6	4×10^{-3}	$\mathbf{10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{4\times10^{-8}}$
		Spleen	7	4×10^{-3}	$\mathbf{10^{-7}}$	10^{-3}	5×10^{-8}
		Liver	8	5×10^{-3}	2×10^{-7}	2×10^{-3}	6×10^{-8}
		Total Body	20	0.01	4×10^{-7}	4×10^{-3}	10^{-7}
	(Insol)	**Lung**			$\mathbf{3\times10^{-8}}$		$\mathbf{9\times10^{-9}}$
		GI (LLI)		$\mathbf{10^{-3}}$	2×10^{-7}	$\mathbf{4\times10^{-4}}$	6×10^{-8}
$_{77}Ir^{194}$ (β^-)		**GI (LLI)**		$\mathbf{10^{-3}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{8\times10^{-8}}$
	(Sol)	Kidney	7	0.08	3×10^{-6}	0.03	10^{-6}
		Liver	8	0.09	3×10^{-6}	0.03	10^{-6}
		Spleen	8	0.09	4×10^{-6}	0.03	10^{-6}
		Total Body	20	0.3	10^{-5}	0.1	4×10^{-6}
	(Insol)	**GI (LLI)**		$\mathbf{9\times10^{-4}}$	$\mathbf{2\times10^{-7}}$	$\mathbf{3\times10^{-4}}$	$\mathbf{5\times10^{-8}}$
		Lung			10^{-6}		4×10^{-7}
$_{78}Pt^{191}$ (ϵ, γ)		**GI (LLI)**		$\mathbf{4\times10^{-3}}$	8×10^{-7}	$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$
	(Sol)	Kidney	10	0.04	10^{-6}	0.01	5×10^{-7}
		Total Body	30	0.1	4×10^{-6}	0.03	10^{-6}
		Liver	30	0.1	4×10^{-6}	0.04	2×10^{-6}
		Spleen	70	0.2	8×10^{-6}	0.08	3×10^{-6}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
(Insol)	**GI (LLI)**	----	3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
	Lung	----	----	8×10^{-7}	----	3×10^{-7}
$_{78}Pt^{193m}$ (ϵ, γ)	**GI (LLI)**	----	**0.03**	7×10^{-6}	**0.01**	2×10^{-6}
	Kidney	100	0.3	10^{-5}	0.1	4×10^{-6}
(Sol)	Total Body	300	0.8	3×10^{-5}	0.3	10^{-5}
	Liver	300	1	4×10^{-5}	0.3	10^{-5}
	Spleen	600	2	7×10^{-5}	0.7	2×10^{-5}
(Insol)	**GI (LLI)**	----	**0.03**	5×10^{-6}	**0.01**	2×10^{-6}
	Lung	----	----	7×10^{-6}	----	2×10^{-6}
$_{78}Pt^{193}$ (ϵ)	**Kidney**	70	**0.03**	10^{-6}	9×10^{-3}	4×10^{-7}
	GI (LLI)	----	0.05	10^{-5}	0.02	4×10^{-6}
(Sol)	Spleen	500	0.2	6×10^{-6}	0.06	2×10^{-6}
	Total Body	500	0.2	6×10^{-6}	0.06	2×10^{-6}
	Liver	600	0.2	9×10^{-6}	0.09	3×10^{-6}
(Insol)	**Lung**	----	----	3×10^{-7}	----	10^{-7}
	GI (LLI)	----	**0.05**	8×10^{-6}	**0.02**	3×10^{-6}

$_{78}Pt^{197m}$ (β^-, γ, e^-)		**GI (ULI)**		**0.03**	**6×10^{-6}**	**0.01**	**2×10^{-6}**
		Kidney	5	0.8	3×10^{-5}	0. 3	10^{-5}
	(Sol)	Liver	20	3	10^{-4}	1	4×10^{-5}
		Spleen	30	5	2×10^{-4}	2	7×10^{-5}
		Total Body	40	6	2×10^{-4}	2	7×10^{-5}
	(Insol)	**GI (ULI)**		**0.03**	**5×10^{-6}**	**9×10^{-3}**	**2×10^{-6}**
		Lung			2×10^{-5}		8×10^{-6}
$_{78}Pt^{197}$ (β^-, γ)		**GI (LLI)**		**4×10^{-3}**	**8×10^{-7}**	**10^{-3}**	**3×10^{-7}**
		Kidney	10	0.1	5×10^{-6}	0.05	2×10^{-6}
	(Sol)	Liver	40	0.6	2×10^{-5}	0.2	7×10^{-6}
		Spleen	70	0.8	3×10^{-5}	0.3	10^{-5}
		Total Body	80	1	4×10^{-5}	0.3	10^{-5}
	(Insol)	**GI (LLI)**		**3×10^{-3}**	**6×10^{-7}**	**10^{-3}**	**2×10^{-7}**
		Lung			4×10^{-6}		10^{-6}
$_{79}Au^{196}$ (β^-, γ, e^-)		**GI (LLI)**		**5×10^{-3}**	**10^{-6}**	**2×10^{-3}**	**4×10^{-7}**
		Total Body	40	0.07	3×10^{-6}	0.03	9×10^{-7}
	(Sol)	Kidney	50	0.09	4×10^{-6}	0.03	10^{-6}
		Spleen	200	0.3	10^{-5}	0.1	4×10^{-6}
		Liver	200	0.3	10^{-5}	0.1	4×10^{-6}
	(Insol)	**Lung**			**6×10^{-7}**		**2×10^{-7}**
		GI (LLI)		**4×10^{-3}**	8×10^{-7}	**10^{-3}**	3×10^{-7}
$_{79}Au^{198}$ (β^-, γ)		**GI (LLI)**		**2×10^{-3}**	**3×10^{-7}**	**5×10^{-4}**	**10^{-7}**
		Kidney	20	0.07	3×10^{-6}	0.02	9×10^{-7}
	(Sol)	Total Body	30	0.1	4×10^{-6}	0.04	2×10^{-6}
		Spleen	60	0.2	8×10^{-6}	0.07	3×10^{-6}
		Liver	80	0.3	10^{-5}	0.1	4×10^{-6}
	(Insol)	**GI (LLI)**		**10^{-3}**	**2×10^{-7}**	**5×10^{-4}**	**8×10^{-8}**
		Lung			6×10^{-7}		2×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{79}Au^{199}$ (β^-, γ)	**GI (LLI)**		5×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
	Kidney	70	0.2	8×10^{-6}	0.07	3×10^{-6}
(Sol)	Total Body	100	0.3	10^{-5}	0.1	4×10^{-6}
	Spleen	200	0.6	2×10^{-5}	0.2	8×10^{-6}
	Liver	300	0.8	3×10^{-5}	0.3	10^{-5}
	GI (LLI)		4×10^{-3}	8×10^{-7}	2×10^{-3}	3×10^{-7}
(Insol)	Lung			2×10^{-6}		6×10^{-7}
$_{80}Hg^{197m}$ (ϵ, γ, e^-)	**Kidney**	4	6×10^{-3}	7×10^{-7}	2×10^{-3}	3×10^{-7}
	GI (LLI)		0.02	4×10^{-6}	7×10^{-3}	10^{-6}
(Sol)	Spleen	40	0.05	7×10^{-6}	0.02	2×10^{-6}
	Liver	50	0.07	9×10^{-6}	0.02	3×10^{-6}
	Total Body	70	0.09	10^{-5}	0.03	4×10^{-6}
	GI (LLI)		5×10^{-3}	8×10^{-7}	2×10^{-3}	3×10^{-7}
(Insol)	Lung			4×10^{-6}		10^{-6}
$_{80}Hg^{197}$ (ϵ, γ, e^-)	**Kidney**	20	9×10^{-3}	10^{-6}	3×10^{-3}	4×10^{-7}
	GI (LLI)		0.06	10^{-5}	0.02	4×10^{-6}
(Sol)	Spleen	200	0.08	10^{-5}	0.03	4×10^{-6}
	Liver	200	0.1	10^{-5}	0.03	4×10^{-6}
	Total Body	200	0.1	2×10^{-5}	0.04	5×10^{-6}

	(Insol)	**GI (LLI)**		**0.01**	**3×10^{-6}**	**5×10^{-3}**	**9×10^{-7}**
		Lung			5×10^{-6}		2×10^{-6}
$_{80}Hg^{203}$ (β^-, γ, e^-)	(Sol)	**Kidney**	4	**5×10^{-4}**	**7×10^{-8}**	**2×10^{-4}**	**2×10^{-8}**
		Spleen	40	6×10^{-3}	8×10^{-7}	2×10^{-3}	3×10^{-7}
		Liver	40	7×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
		Total Body	80	0.01	2×10^{-6}	4×10^{-3}	5×10^{-7}
		GI (LLI)		0.01	3×10^{-6}	4×10^{-3}	10^{-6}
	(Insol)	**Lung**			**10^{-7}**		**4×10^{-8}**
		GI (LLI)		**3×10^{-3}**	6×10^{-7}	**10^{-3}**	2×10^{-7}
$_{81}Tl^{200}$ (ϵ, γ)	(Sol)	**GI (LLI)**		**0.01**	**3×10^{-6}**	**4×10^{-3}**	**9×10^{-7}**
		Kidney	40	0.08	8×10^{-6}	0.03	3×10^{-6}
		Total Body	50	0.1	10^{-5}	0.04	4×10^{-6}
		Muscle	100	0.3	3×10^{-5}	0.09	9×10^{-6}
		Liver	200	0.4	5×10^{-5}	0.2	2×10^{-5}
		Lung	800	2	2×10^{-4}	0.6	6×10^{-5}
		Bone	10^3	2	2×10^{-4}	0.8	9×10^{-5}
	(Insol)	**GI (LLI)**		**7×10^{-3}**	**10^{-6}**	**2×10^{-3}**	**4×10^{-7}**
		Lung			4×10^{-6}		10^{-6}
$_{81}Tl^{201}$ (ϵ, γ, e^-)	(Sol)	**GI (LLI)**		**9×10^{-3}**	**2×10^{-6}**	**3×10^{-3}**	**7×10^{-7}**
		Kidney	40	0.04	5×10^{-6}	0.02	2×10^{-6}
		Total Body	100	0.1	10^{-5}	0.04	4×10^{-6}
		Muscle	300	0.3	3×10^{-5}	0.1	10^{-5}
		Liver	300	0.3	3×10^{-5}	0.1	10^{-5}
		Bone	400	0.4	5×10^{-5}	0.2	2×10^{-5}
		Lung	10^3	1	10^{-4}	0.4	4×10^{-5}
	(Insol)	**GI (LLI)**		**5×10^{-3}**	**9×10^{-7}**	**2×10^{-3}**	**3×10^{-7}**
		Lung			2×10^{-6}		7×10^{-7}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations for radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{81}Tl^{202}$ (ϵ, γ, e^-)		**GI (LLI)**		4×10^{-3}	8×10^{-7}	10^{-3}	3×10^{-7}
		Kidney	20	0.01	10^{-6}	3×10^{-3}	4×10^{-7}
		Total Body	50	0.03	3×10^{-6}	0.01	10^{-6}
	(Sol)	Muscle	100	0.07	7×10^{-6}	0.02	2×10^{-6}
		Liver	100	0.08	8×10^{-6}	0.03	3×10^{-6}
		Bone	200	0.1	10^{-5}	0.03	4×10^{-6}
		Lung	400	0.3	3×10^{-5}	0.09	9×10^{-6}
	(Insol)	**Lung**			2×10^{-7}		8×10^{-8}
		GI (LLI)		2×10^{-3}	4×10^{-7}	7×10^{-4}	10^{-7}
$_{81}Tl^{204}$ (β^-)		**GI (LLI)**		3×10^{-3}	7×10^{-7}	10^{-3}	2×10^{-7}
		Kidney	10	6×10^{-3}	6×10^{-7}	2×10^{-3}	2×10^{-7}
		Total Body	80	0.03	3×10^{-6}	0.01	10^{-6}
	(Sol)	Bone	100	0.04	5×10^{-6}	0.02	2×10^{-6}
		Liver	100	0.06	6×10^{-6}	0.02	2×10^{-6}
		Muscle	200	0.07	7×10^{-6}	0.02	3×10^{-6}
		Lung	500	0.2	2×10^{-5}	0.07	7×10^{-6}
	(Insol)	**Lung**			3×10^{-8}		9×10^{-9}
		GI (LLI)		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}

$_{82}Pb^{203}(\epsilon, \gamma)$		**GI (LLI)**		**0.01**	3×10^{-6}	4×10^{-3}	9×10^{-7}
	(Sol)	Kidney	30	0.1	4×10^{-6}	0.05	10^{-6}
		Total Body	90	0.5	10^{-5}	0.2	5×10^{-6}
		Liver	200	1	3×10^{-5}	0.3	10^{-5}
		Bone	400	2	7×10^{-5}	0.8	2×10^{-5}
	(Insol)	**GI (LLI)**		**0.01**	2×10^{-6}	4×10^{-3}	6×10^{-7}
		Lung			4×10^{-6}		10^{-6}
$_{82}Pb^{210}(\alpha, \beta^-, \gamma)$		**Kidney**	0.4	4×10^{-6}	10^{-10}	10^{-6}	4×10^{-11}
		Total Body	4	4×10^{-6}	10^{-9}	10^{-6}	4×10^{-10}
	(Sol)	Bone	0.7	6×10^{-6}	2×10^{-10}	2×10^{-6}	7×10^{-11}
		Liver	1	10^{-5}	4×10^{-10}	5×10^{-6}	10^{-10}
		GI (LLI)		6×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
		Lung			2×10^{-10}		8×10^{-11}
	(Insol)	**GI (LLI)**		**5×10^{-3}**	9×10^{-7}	**2×10^{-3}**	3×10^{-7}
$_{82}Pb^{212}(\alpha, \beta^-, \gamma, e^-)$		**Kidney**	0.02	**6×10^{-4}**	2×10^{-8}	**2×10^{-4}**	**6×10^{-9}**
		GI (LLI)		**6×10^{-4}**	10^{-7}	**2×10^{-4}**	4×10^{-8}
	(Sol)	Bone	0.1	2×10^{-3}	7×10^{-8}	8×10^{-4}	3×10^{-8}
		Liver	0.2	6×10^{-3}	2×10^{-7}	2×10^{-3}	6×10^{-8}
		Total body	0.2	6×10^{-3}	2×10^{-7}	2×10^{-3}	6×10^{-8}
		Lung			2×10^{-8}		7×10^{-9}
	(Insol)	**GI (LLI)**		**5×10^{-4}**	9×10^{-8}	**2×10^{-4}**	3×10^{-8}
$_{83}Bi^{206}$ (ϵ, γ)		**GI (LLI)**		**10^{-3}**	2×10^{-7}	**4×10^{-4}**	8×10^{-8}
		Kidney	1	0.04	2×10^{-7}	0.02	6×10^{-8}
	(Sol)	Liver	7	0.2	10^{-6}	0.08	4×10^{-7}
		Total Body	10	0.4	2×10^{-6}	0.1	5×10^{-7}
		Spleen	20	0.5	2×10^{-6}	0.2	8×10^{-7}
		Bone	300	10	4×10^{-5}	3	10^{-5}
	(Inso.)	**Lung**			**10^{-7}**		**5×10^{-8}**
		GI (LLI)		**10^{-3}**	2×10^{-7}	**4×10^{-4}**	7×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(PMPC)_a$ $\mu c/cc$
$_{83}Bi^{207}$ (ϵ, γ)		**GI (LLI)**	----------	**2×10^{-3}**	4×10^{-7}	**6×10^{-4}**	10^{-7}
	(Sol)	**Kidney**	2	0.04	**2×10^{-7}**	0.02	**6×10^{-8}**
		Liver	7	0.1	6×10^{-7}	0.05	2×10^{-7}
		Spleen	20	0.4	2×10^{-6}	0.1	5×10^{-7}
		Total Body	20	0.4	2×10^{-6}	0.1	5×10^{-7}
		Bone	300	6	2×10^{-5}	2	8×10^{-6}
	(Insol)	**Lung**	----------	----------	**10^{-8}**	----------	**5×10^{-9}**
		GI (LLI)	----------	**2×10^{-3}**	3×10^{-7}	**6×10^{-4}**	10^{-7}
$_{83}Bi^{210}$ (α, β^-)		**GI (LLI)**	----------	**10^{-3}**	3×10^{-7}	**4×10^{-4}**	9×10^{-8}
	(Sol)	**Kidney**	0.04	2×10^{-3}	**6×10^{-9}**	5×10^{-4}	**2×10^{-9}**
		Liver	0.5	0.02	8×10^{-8}	6×10^{-3}	3×10^{-8}
		Spleen	0.6	0.02	10^{-7}	8×10^{-3}	3×10^{-8}
		Total Body	20	0.07	3×10^{-7}	0.03	10^{-7}
		Bone	6	0.2	10^{-6}	0.08	3×10^{-7}
	(Insol)	**Lung**	----------	----------	**6×10^{-9}**	----------	**2×10^{-9}**
		GI (LLI)	----------	**10^{-3}**	2×10^{-7}	**4×10^{-4}**	7×10^{-8}

$_{83}Bi^{212}(\alpha, \beta^-, \gamma)$		**GI (S)**		**0.01**	2×10^{-6}	$\mathbf{4\times10^{-3}}$	8×10^{-7}
		Kidney	0.01	0.02	$\mathbf{10^{-7}}$	8×10^{-3}	$\mathbf{3\times10^{-8}}$
	(Sol)	Liver	0.1	0.3	10^{-6}	0.09	4×10^{-7}
		Spleen	0.2	0.4	10^{-6}	0.1	5×10^{-7}
		Total Body	**0.2**	0.5	2×10^{-6}	0.2	8×10^{-7}
		Bone	0.9	2	8×10^{-6}	0.7	3×10^{-6}
	(Insol)	**Lung**			$\mathbf{2\times10^{-7}}$		$\mathbf{7\times10^{-8}}$
		GI (S)		**0.01**	2×10^{-6}	$\mathbf{4\times10^{-3}}$	6×10^{-7}
$_{84}Po^{210}(\alpha)$		**Spleen**	0.03	$\mathbf{2\times10^{-5}}$	$\mathbf{5\times10^{-10}}$	$\mathbf{7\times10^{-6}}$	$\mathbf{2\times10^{-10}}$
		Kidney	0.04	$\mathbf{2\times10^{-5}}$	$\mathbf{5\times10^{-10}}$	8×10^{-6}	$\mathbf{2\times10^{-10}}$
	(Sol)	Liver	0.1	7×10^{-5}	2×10^{-9}	3×10^{-5}	6×10^{-10}
		Total Body	0.4	2×10^{-4}	5×10^{-9}	8×10^{-5}	2×10^{-9}
		Bone	0.5	3×10^{-4}	7×10^{-9}	10^{-4}	2×10^{-9}
		GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	7×10^{-8}
	(Insol)	**Lung**			$\mathbf{2\times10^{-10}}$		$\mathbf{7\times10^{-11}}$
		GI (LLI)		$\mathbf{8\times10^{-4}}$	2×10^{-7}	$\mathbf{3\times10^{-4}}$	5×10^{-8}
$_{85}At^{211}(\alpha, \epsilon, \gamma)$		**Thyroid**	0.02	$\mathbf{5\times10^{-5}}$	$\mathbf{7\times10^{-9}}$	$\mathbf{2\times10^{-5}}$	$\mathbf{2\times10^{-9}}$
		Ovary	0.02	$\mathbf{5\times10^{-5}}$	$\mathbf{7\times10^{-9}}$	$\mathbf{2\times10^{-5}}$	$\mathbf{3\times10^{-9}}$
	(Sol)	Spleen	0.06	2×10^{-4}	3×10^{-8}	6×10^{-5}	9×10^{-9}
		Total Body	0.3	8×10^{-4}	10^{-7}	3×10^{-4}	4×10^{-8}
		GI (S)		0.02	4×10^{-6}	7×10^{-3}	2×10^{-6}
	(Insol)	**Lung**			$\mathbf{3\times10^{-8}}$		$\mathbf{10^{-8}}$
		GI (ULI)		$\mathbf{2\times10^{-3}}$	4×10^{-7}	$\mathbf{7\times10^{-4}}$	10^{-7}
$_{86}Rn^{220}$†$(\alpha, \beta^-, \gamma, e^-)$		**Lung**			$\mathbf{3\times10^{-7}}$		$\mathbf{10^{-7}}$
$_{86}Rn^{222}$†(α, β, γ)		**Lung**			$\mathbf{3\times10^{-8}}$		$\mathbf{10^{-8}}$

†The daughter isotopes of Rn^{220} and Rn^{222} are assumed present to the extent they occur in unfiltered air. For all other isotopes the daughter elements are not considered as part of the intake and if present must be considered on the basis of the rules for mixtures.

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week**	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{88}Ra^{223}$ (α, β^-, γ)	(Sol)	**Bone**	0.05	2×10^{-5}	2×10^{-9}	7×10^{-6}	6×10^{-10}
		Total Body	0.07	4×10^{-5}	3×10^{-9}	10^{-5}	10^{-9}
		GI (LLI)		2×10^{-4}	4×10^{-8}	6×10^{-5}	10^{-8}
	(Insol)	**Lung**			2×10^{-10}		8×10^{-11}
		GI (LLI)		10^{-4}	2×10^{-8}	4×10^{-5}	7×10^{-9}
$_{88}Ra^{224}$ (α, β^-, γ, e^-)	(Sol)	**Bone**	0.06	7×10^{-5}	5×10^{-9}	2×10^{-5}	2×10^{-9}
		Total Body	0.07	9×10^{-5}	8×10^{-9}	3×10^{-5}	3×10^{-9}
		GI (LLI)		2×10^{-4}	5×10^{-8}	7×10^{-5}	2×10^{-8}
	(Insol)	**Lung**			7×10^{-10}		2×10^{-10}
		GI (LLI)		2×10^{-4}	3×10^{-8}	5×10^{-5}	9×10^{-9}
$_{88}Ra^{226}$ (α, β^-, γ)	(Sol)	**Bone**	0.1	4×10^{-7}	3×10^{-11}	10^{-7}	10^{-11}
		Total Body	0.2	6×10^{-7}	5×10^{-11}	2×10^{-7}	2×10^{-11}
		GI (LLI)		10^{-3}	3×10^{-7}	5×10^{-4}	10^{-7}
	(Insol)	**GI (LLI)**		9×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
$_{88}Ra^{228}$ (α, β^-, γ, e^-)	(Sol)	**Bone**	0.06	8×10^{-7}	7×10^{-11}	3×10^{-7}	2×10^{-11}
		Total Body	0.09	10^{-6}	9×10^{-11}	4×10^{-7}	3×10^{-11}
		GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	8×10^{-8}

	(Insol)	**Lung**			$\mathbf{4\times10^{-11}}$		$\mathbf{10^{-11}}$
		GI (LLI)		$\mathbf{7\times10^{-4}}$	10^{-7}	$\mathbf{3\times10^{-4}}$	4×10^{-8}
$_{89}Ac^{227}$ (α, β^-, γ)	(Sol)	**Bone**	0.03	$\mathbf{6\times10^{-5}}$	$\mathbf{2\times10^{-12}}$	$\mathbf{2\times10^{-5}}$	$\mathbf{8\times10^{-13}}$
		Total Body	0.1	2×10^{-4}	7×10^{-12}	6×10^{-5}	3×10^{-12}
		Liver	0.2	2×10^{-4}	10^{-11}	8×10^{-5}	3×10^{-12}
		Kidney	0.4	7×10^{-4}	3×10^{-11}	2×10^{-4}	9×10^{-12}
		GI (LLI)		9×10^{-3}	2×10^{-6}	3×10^{-3}	7×10^{-7}
	(Insol)	**Lung**			$\mathbf{3\times10^{-11}}$		$\mathbf{9\times10^{-12}}$
		GI (LLI)		$\mathbf{9\times10^{-3}}$	2×10^{-6}	$\mathbf{3\times10^{-3}}$	5×10^{-7}
$_{89}Ac^{228}$ (α, β^-, γ, e^-)	(Sol)	**GI (ULI)**		$\mathbf{3\times10^{-3}}$	6×10^{-7}	$\mathbf{9\times10^{-4}}$	2×10^{-7}
		Bone	0.04	2	9×10^{-8}	0.5	$\mathbf{3\times10^{-8}}$
		Liver	0.05	2	$\mathbf{8\times10^{-8}}$	0.6	$\mathbf{3\times10^{-8}}$
		Total Body	0.09	3	10^{-7}	1	5×10^{-8}
		Kidney	0.5	20	6×10^{-7}	6	2×10^{-7}
	(Insol)	**Lung**			$\mathbf{2\times10^{-8}}$		$\mathbf{6\times10^{-9}}$
		GI (ULI)		$\mathbf{3\times10^{-3}}$	4×10^{-7}	$\mathbf{9\times10^{-4}}$	2×10^{-7}
$_{90}Th^{227}$ (α, β^-, γ)	(Sol)	**GI (LLI)**		$\mathbf{5\times10^{-4}}$	10^{-7}	$\mathbf{2\times10^{-4}}$	4×10^{-8}
		Bone	0.02	8×10^{-3}	$\mathbf{3\times10^{-10}}$	3×10^{-3}	$\mathbf{10^{-10}}$
		Kidney	0.08	0.04	2×10^{-9}	0.01	6×10^{-10}
		Total Body	0.1	0.05	2×10^{-9}	0.02	7×10^{-10}
		Liver	0.5	0.2	10^{-8}	0.08	4×10^{-9}
	(Insol)	**Lung**			$\mathbf{2\times10^{-10}}$		$\mathbf{6\times10^{-11}}$
		GI (LLI)		$\mathbf{5\times10^{-4}}$	9×10^{-8}	$\mathbf{2\times10^{-4}}$	3×10^{-8}
$_{90}Th^{228}$ (α, β^-, γ, e^-)	(Sol)	**Bone**	0.02	$\mathbf{2\times10^{-4}}$	$\mathbf{9\times10^{-12}}$	$\mathbf{7\times10^{-5}}$	$\mathbf{3\times10^{-12}}$
		GI (LLI)		4×10^{-4}	8×10^{-8}	10^{-4}	3×10^{-8}
		Kidney	0.09	10^{-3}	5×10^{-11}	4×10^{-4}	2×10^{-11}
		Total Body	0.09	10^{-3}	5×10^{-11}	4×10^{-4}	2×10^{-11}
		Liver	0.5	7×10^{-3}	3×10^{-10}	2×10^{-3}	10^{-10}
	(Insol)	**Lung**			$\mathbf{6\times10^{-12}}$		$\mathbf{2\times10^{-12}}$
		GI (LLI)		$\mathbf{4\times10^{-4}}$	7×10^{-8}	$\mathbf{10^{-4}}$	2×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week**	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{90}Th^{230}$ (α, γ)						
(Sol)	**Bone**	0.05	5×10^{-5}	2×10^{-12}	2×10^{-5}	8×10^{-13}
	Kidney	0.3	10^{-4}	4×10^{-12}	3×10^{-5}	2×10^{-12}
	Total Body	0.4	3×10^{-4}	2×10^{-11}	10^{-4}	5×10^{-12}
	Liver	0.6	5×10^{-4}	2×10^{-11}	2×10^{-4}	7×10^{-12}
	GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	7×10^{-8}
(Insol)	**Lung**			10^{-11})		3×10^{-12}
	GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
$_{90}Th^{231}$ (α, β^-, γ)						
(Sol)	**GI (LLI)**		7×10^{-3}	10^{-6}	2×10^{-3}	5×10^{-7}
	Bone	30	200	10^{-5}	80	4×10^{-6}
	Kidney	40	300	10^{-5}	100	5×10^{-6}
	Total Body	100	900	4×10^{-5}	300	10^{-5}
	Liver	300	2×10^{3}	10^{-4}	800	3×10^{-5}
(Insol)	**GI (LLI)**		7×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
	Lung			6×10^{-6}		2×10^{-6}
$_{90}Th^{232}$ (α, β^-, γ, e^-)						
(Sol)	**Bone**	0.04	5×10^{-5}	(2×10^{-12})	2×10^{-5}	(7×10^{-13}) ‡
	Kidney	0.3	10^{-4}	(5×10^{-12})	4×10^{-5}	(2×10^{-12})
	Total Body	0.3	3×10^{-4}	(10^{-11})	9×10^{-5}	(4×10^{-12})
	Liver	0.7	6×10^{-4}	3×10^{-11}	2×10^{-4}	(9×10^{-12})
	GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	8×10^{-8}

	(Insol)	**Lung**			10^{-11}		4×10^{-12}
		GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	7×10^{-8}
$_{90}Th^{234}$ (β^-, γ)		**GI (LLI)**		5×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
	(Sol)	**Bone**	4	1	6×10^{-8}	0.5	2×10^{-8}
		Kidney	6	2	9×10^{-8}	0.7	3×10^{-8}
		Total Body	20	8	4×10^{-7}	3	10^{-7}
		Liver	30	10	5×10^{-7}	4	2×10^{-7}
	(Insol)	**Lung**			3×10^{-8}		10^{-8}
		GI (LLI)		5×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
$_{90}$Th–Nat (α, β^-, γ, e^-)		**Bone**	0.01	3×10^{-5}	(2×10^{-12})	10^{-5}	(6×10^{-13})‡
		Kidney	0.07	10^{-4}	(4×10^{-12})	4×10^{-5}	(2×10^{-12})
	(Sol)	Total Body	0.07	2×10^{-4}	(9×10^{-12})	7×10^{-5}	(3×10^{-12})
		GI (LLI)		3×10^{-4}	6×10^{-8}	10^{-4}	2×10^{-8}
		Liver	0.3	5×10^{-4}	(2×10^{-11})	2×10^{-4}	(8×10^{-12})
	(Insol)	**Lung**			(4×10^{-12})		(10^{-12})
		GI (LLI)		3×10^{-4}	5×10^{-8}	10^{-4}	2×10^{-8}
$_{91}Pa^{230}$ (α, β^-, ϵ, γ)		**GI (LLI)**		7×10^{-3}	2×10^{-6}	2×10^{-3}	5×10^{-7}
	(Sol)	**Bone**	0.07	0.04	2×10^{-9}	0.01	6×10^{-10}
		Kidney	0.2	0.1	5×10^{-9}	0.04	2×10^{-9}
		Total Body	0.3	0.2	8×10^{-9}	0.06	3×10^{-9}
	(Insol)	**Lung**			8×10^{-10}		3×10^{-10}
		GI (LLI)		7×10^{-3}	10^{-6}	2×10^{-3}	4×10^{-7}
$_{91}Pa^{231}$ (α, β^-, γ)		**Bone**	0.02	3×10^{-5}	10^{-12}	9×10^{-6}	4×10^{-13}
		Kidney	0.06	7×10^{-5}	3×10^{-12}	2×10^{-5}	10^{-12}
	(Sol)	Total Body	0.1	10^{-4}	5×10^{-12}	4×10^{-5}	2×10^{-12}
		Liver	0.3	4×10^{-4}	2×10^{-11}	10^{-4}	5×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	(Insol)	**Lung**			10^{-10}		4×10^{-11}
		GI (LLI)		8×10^{-4}	10^{-7}	2×10^{-4}	5×10^{-8}

‡Provisional values for Th^{232} and Th-nat. Although calculations and animal experiments suggest that Th-nat is perhaps as hazardous as Pu and indicate the values listed above, industrial experience to date has suggested that the hazard of Th-nat is not much greater than that of U-nat. The NCRP has recognized that a certain period of time may be required for adjustment of operations to comply with new recommendations. Therefore, pending further investigation the values $(MPC)_a=3\times10^{-11}$ μc/cc for the 40-hour week and $(MPC)_a=10^{-11}$ μc/cc for continuous occupational exposure (168 hr/wk) are recommended as permissible levels. These values are essentially those that have been generally used in this country (Federal Register 1957). However, the values given in Table 1 are listed to indicate the possibility that further evidence may require lower values and to urge especially that exposure levels of Th-nat be kept as low as is operationally possible. The exception indicated here applies only to the $(MPC)_a$ values for Th-nat and Th^{232}.

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{91}Pa^{233}$ (β^-, γ)		**GI (LLI)**		4×10^{-3}	8×10^{-7}	10^{-3}	3×10^{-7}
	(Sol)	**Kidney**	40	10	6×10^{-7}	5	2×10^{-7}
		Bone	60	20	9×10^{-7}	7	3×10^{-7}
		Total Body	60	20	9×10^{-7}	7	3×10^{-7}
		Liver	200	50	2×10^{-6}	20	8×10^{-7}
	(Insol)	**Lung**			2×10^{-7}		6×10^{-8}
		GI (LLI)		3×10^{-3}	6×10^{-7}	10^{-3}	2×10^{-7}
$_{92}U^{230}$ (α, β^-, γ)		**GI (LLI)**		10^{-4}	3×10^{-8}	5×10^{-5}	10^{-8}
	(Sol)	**Kidney**	0.01	7×10^{-3}	3×10^{-10}	2×10^{-3}	10^{-10}
		Total Body	0.06	0.03	10^{-9}	0.01	5×10^{-10}
		Bone	7×10^{-3}	0.04	2×10^{-9}	0.02	6×10^{-10}
	(Insol)	**Lung**			10^{-10}		4×10^{-11}
		GI (LLI)		10^{-4}	2×10^{-8}	5×10^{-5}	8×10^{-9}
$_{92}U^{232}$ (α, β^-, γ, e^-)		**GI (LLI)**		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	(Sol)	**Bone**	0.01	2×10^{-3}	10^{-10}	8×10^{-4}	3×10^{-11}
		Total Body	0.07	6×10^{-3}	3×10^{-10}	2×10^{-3}	10^{-10}
		Kidney	0.04	0.01	6×10^{-10}	4×10^{-3}	2×10^{-10}
	(Insol)	**Lung**			3×10^{-11}		9×10^{-12}
		GI (LLI)		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}

$_{92}U^{233}$ (α, γ)	(Sol)	**GI (LLI)**		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	7×10^{-8}
		Bone	0.05	0.01	**5×10^{-10}**	**4×10^{-3}**	**2×10^{-10}**
		Kidney	0.08	0.03	10^{-9}	0.01	4×10^{-10}
		Total Body	0.4	0.04	2×10^{-9}	0.01	5×10^{-10}
	(Insol)	**Lung**			10^{-10}		**4×10^{-11}**
		GI (LLI)		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
$_{92}U^{234}$ (α, γ)	(Sol)	**GI (LLI)**		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	7×10^{-8}
		Bone	0.05	0.01	**6×10^{-10}**	4×10^{-3}	**2×10^{-10}**
		Kidney	0.08	0.03	10^{-9}	0.01	4×10^{-10}
		Total Body	0.4	0.04	2×10^{-9}	0.01	6×10^{-10}
	(Insol)	**Lung**			10^{-10}		**4×10^{-11}**
		GI (LLI)		**9×10^{-4}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
$_{92}U^{235}$ (α, β^-, γ)	(Sol)	**GI (LLI)**		**8×10^{-4}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
		Kidney	0.03	0.01	**5×10^{-10}**	4×10^{-3}	**2×10^{-10}**
		Bone	0.06	0.01	6×10^{-10}	5×10^{-3}	**2×10^{-10}**
		Total Body	0.4	0.04	2×10^{-9}	0.01	6×10^{-10}
	(Insol)	**Lung**			10^{-10}		**4×10^{-11}**
		GI (LLI)		**8×10^{-4}**	10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{92}U^{236}$ (α, γ)	(Sol)	**GI (LLI)**		**10^{-3}**	2×10^{-7}	**3×10^{-4}**	7×10^{-8}
		Bone	0.06	0.01	**6×10^{-10}**	5×10^{-3}	**2×10^{-10}**
		Kidney	0.08	0.03	10^{-9}	0.01	4×10^{-10}
		Total Body	0.4	0.04	2×10^{-9}	0.01	6×10^{-10}
	(Insol)	**Lung**			10^{-10}		**4×10^{-11}**
		GI (LLI)		**10^{-3}**	2×10^{-7}	**3×10^{-4}**	6×10^{-8}
$_{92}U^{238}$ (α, γ, e^-)	(Sol)	**GI (LLI)**		**10^{-3}**	2×10^{-7}	**4×10^{-4}**	8×10^{-8}
		Kidney	5×10^{-3}	2×10^{-3}	**7×10^{-11}**	6×10^{-4}	**3×10^{-11}**
		Bone	0.06	0.01	6×10^{-10}	5×10^{-3}	2×10^{-10}
		Total Body	0.5	0.04	2×10^{-9}	0.01	6×10^{-10}
	(Insol)	**Lung**			10^{-10}		**5×10^{-11}**
		GI (LLI)		**10^{-3}**	2×10^{-7}	**4×10^{-4}**	6×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay		Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
				For 40 hour week		For 168 hour week	
				$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(PMPC)_a$ $\mu c/cc$
$_{92}U$–Nat (α, β^-, γ, e^-)							
	(Sol)	**GI (LLI)**		$\mathbf{5\times10^{-4}}$	$\mathbf{10^{-7}}$	$\mathbf{2\times10^{-4}}$	$\mathbf{4\times10^{-8}}$
		Kidney	$\mathbf{5\times10^{-3}}$	$\mathbf{2\times10^{-3}}$	$\mathbf{7\times10^{-11}}$	$\mathbf{6\times10^{-4}}$	$\mathbf{3\times10^{-11}}$
		Bone	0.03	6×10^{-3}	3×10^{-10}	2×10^{-3}	10^{-10}
		Total Body	0.2	0.02	8×10^{-10}	7×10^{-3}	3×10^{-10}
	(Insol)	**Lung**			$\mathbf{6\times10^{-11}}$		$\mathbf{2\times10^{-11}}$
		GI (LLI)		$\mathbf{5\times10^{-4}}$	8×10^{-8}	$\mathbf{2\times10^{-4}}$	3×10^{-8}
$_{92}Np^{237}$ (α, β^-, γ)							
	(Sol)	**Bone**	0.06	$\mathbf{9\times10^{-5}}$	$\mathbf{4\times10^{-12}}$	$\mathbf{3\times10^{-5}}$	$\mathbf{10^{-12}}$
		Kidney	0.1	2×10^{-4}	7×10^{-12}	6×10^{-5}	2×10^{-12}
		Total Body	0.5	4×10^{-4}	2×10^{-11}	10^{-4}	6×10^{-12}
		Liver	0.5	6×10^{-4}	2×10^{-11}	2×10^{-4}	8×10^{-12}
		GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	7×10^{-8}
	(Insol)	**Lung**			$\mathbf{10^{-10}}$		$\mathbf{4\times10^{-11}}$
		GI (LLI)		$\mathbf{9\times10^{-4}}$	2×10^{-7}	$\mathbf{3\times10^{-4}}$	5×10^{-8}
$_{93}Np^{239}$ (α, β^-, γ)							
	(Sol)	**GI (LLI)**		$\mathbf{4\times10^{-3}}$	$\mathbf{8\times10^{-7}}$	$\mathbf{10^{-3}}$	$\mathbf{3\times10^{-7}}$
		Bone	30	100	4×10^{-6}	30	2×10^{-6}
		Kidney	40	200	7×10^{-6}	50	2×10^{-6}
		Total Body	70	300	10^{-5}	90	4×10^{-6}
		Liver	100	500	2×10^{-5}	200	8×10^{-6}

	(Insol)	**GI (LLI)**		**4×10^{-3}**	**7×10^{-7}**	**10^{-3}**	**2×10^{-7}**
		Lung			2×10^{-6}		7×10^{-7}
$_{94}Pu^{238}$ (α, γ)		**Bone**	0.04	**10^{-4}**	**2×10^{-12}**	**5×10^{-5}**	**7×10^{-13}**
		Liver	0.2	6×10^{-4}	8×10^{-12}	2×10^{-4}	3×10^{-12}
	(Sol)	Kidney	0.3	8×10^{-4}	10^{-11}	3×10^{-4}	4×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Total Body	0.3	10^{-3}	10^{-11}	4×10^{-4}	5×10^{-12}
	(Insol)	**Lung**			**3×10^{-11}**		**10^{-11}**
		GI (LLI)		**8×10^{-4}**	10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{94}Pu^{239}$ (α, γ)		**Bone**	0.04	**10^{-4}**	**2×10^{-12}**	**5×10^{-5}**	**6×10^{-13}**
		Liver	0.4	5×10^{-4}	7×10^{-12}	2×10^{-4}	2×10^{-12}
	(Sol)	Kidney	0.5	7×10^{-4}	9×10^{-12}	2×10^{-4}	3×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Total Body	0.4	10^{-3}	10^{-11}	3×10^{-4}	5×10^{-12}
	(Insol)	**Lung**			**4×10^{-11}**		**10^{-11}**
		GI (LLI)		**8×10^{-4}**	2×10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{94}Pu^{240}$(α, γ)		**Bone**	0.04	**10^{-4}**	**2×10^{-12}**	**5×10^{-5}**	**6×10^{-13}**
		Liver	0.4	5×10^{-4}	7×10^{-12}	2×10^{-4}	2×10^{-12}
	(Sol)	Kidney	0.5	7×10^{-4}	9×10^{-12}	2×10^{-4}	3×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Total Body	0.4	10^{-3}	10^{-11}	3×10^{-4}	5×10^{-12}
	(Insol)	**Lung**			**4×10^{-11}**		**10^{-11}**
		GI (LLI)		**8×10^{-4}**	2×10^{-7}	**3×10^{-4}**	5×10^{-8}
$_{94}Pu^{241}$(α, β^-, γ)		**Bone**	0.9	**7×10^{-3}**	**9×10^{-11}**	**2×10^{-3}**	**3×10^{-11}**
		Kidney	5	0.04	5×10^{-10}	0.01	2×10^{-10}
	(Sol)	GI (LLI)		0.04	8×10^{-6}	0.01	3×10^{-6}
		Total Body	9	0.06	8×10^{-10}	0.02	3×10^{-10}
		Liver	10	0.07	10^{-9}	0.03	3×10^{-10}
	(Insol)	**Lung**			**4×10^{-8}**		**10^{-8}**
		GI (LLI)		**0.04**	7×10^{-6}	**0.01**	2×10^{-6}

TABLE 1. *Maximum peamissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{94}Pu^{242}(\alpha)$	**Bone**	0.05	10^{-4}	2×10^{-12}	5×10^{-5}	6×10^{-13}
	Liver	0.4	6×10^{-4}	7×10^{-12}	2×10^{-4}	3×10^{-12}
(Sol)	Kidney	0.5	7×10^{-4}	10^{-11}	3×10^{-4}	3×10^{-12}
	GI (LLI)		9×10^{-4}	2×10^{-7}	3×10^{-4}	7×10^{-8}
	Total Body	0.4	10^{-3}	10^{-11}	4×10^{-4}	5×10^{-12}
	Lung			4×10^{-11}		10^{-11}
(Insol)	**GI (LLI)**		9×10^{-4}	2×10^{-7}	3×10^{-4}	5×10^{-8}
$_{95}Am^{241}$ (α, γ)	**Kidney**	0.1	10^{-4}	6×10^{-12}	4×10^{-5}	2×10^{-12}
	Bone	0.05	10^{-4}	6×10^{-12}	5×10^{-5}	2×10^{-12}
(Sol)	Liver	0.4	2×10^{-4}	9×10^{-12}	7×10^{-5}	3×10^{-12}
	Total Body	0.3	4×10^{-4}	2×10^{-11}	10^{-4}	5×10^{-12}
	GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	Lung			10^{-10}		4×10^{-11}
(Insol)	**GI (LLI)**		8×10^{-4}	10^{-7}	2×10^{-4}	5×10^{-8}
$_{95}Am^{243}$ $(\alpha, \beta^-, \gamma)$	**Bone**	0.05	10^{-4}	6×10^{-12}	4×10^{-5}	2×10^{-12}
	Kidney	0.1	10^{-4}	6×10^{-12}	5×10^{-5}	2×10^{-12}
(Sol)	Liver	0.4	2×10^{-4}	9×10^{-12}	7×10^{-5}	3×10^{-12}
	Total Body	0.4	4×10^{-4}	2×10^{-11}	10^{-4}	5×10^{-12}
	GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}

	(Insol)	**Lung**			10^{-10}		4×10^{-11}
		GI (LLI)		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}
$_{96}Cm^{242}$ (α, γ)	(Sol)	**GI (LLI)**		7×10^{-4}	2×10^{-7}	2×10^{-4}	5×10^{-8}
		Liver	0.05	3×10^{-3}	10^{-10}	9×10^{-4}	4×10^{-11}
		Bone	0.09	5×10^{-3}	2×10^{-10}	2×10^{-3}	8×10^{-11}
		Kidney	0.2	9×10^{-3}	4×10^{-10}	3×10^{-3}	10^{-10}
		Total Body	0.2	0.01	6×10^{-10}	5×10^{-3}	2×10^{-10}
	(Insol)	**Lung**			2×10^{-10}		6×10^{-11}
		GI (LLI)		7×10^{-4}	10^{-7}	3×10^{-4}	4×10^{-8}
$_{96}Cm^{243}$ (α, γ)	(Sol)	**Bone**	0.09	10^{-4}	6×10^{-12}	5×10^{-5}	2×10^{-12}
		Liver	0.2	2×10^{-4}	10^{-11}	8×10^{-5}	3×10^{-12}
		Kidney	0.2	3×10^{-4}	10^{-11}	10^{-4}	4×10^{-12}
		Total Body	0.3	5×10^{-4}	2×10^{-11}	2×10^{-4}	7×10^{-12}
		GI (LLI)		7×10^{-4}	2×10^{-7}	2×10^{-4}	5×10^{-8}
	(Insol)	**Lung**			10^{-10}		3×10^{-11}
		GI (LLI)		7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
$_{96}Cm^{244}$ (α, γ)	(Sol)	**Bone**	0.1	2×10^{-4}	9×10^{-12}	7×10^{-5}	3×10^{-12}
		Liver	0.2	3×10^{-4}	10^{-11}	9×10^{-5}	4×10^{-12}
		Kidney	0.2	4×10^{-4}	2×10^{-11}	10^{-4}	6×10^{-12}
		Total Body	0.3	6×10^{-4}	3×10^{-11}	2×10^{-4}	9×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	(Insol)	**Lung**			10^{-10}		3×10^{-11}
		GI (LLI)		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}
$_{96}Cm^{245}$ (α, β^-, γ)	(Sol)	**Bone**	0.04	10^{-4}	5×10^{-12}	4×10^{-5}	2×10^{-12}
		Liver	0.5	2×10^{-4}	8×10^{-12}	7×10^{-5}	3×10^{-12}
		Kidney	0.2	2×10^{-4}	9×10^{-12}	7×10^{-5}	3×10^{-12}
		Total Body	0.4	3×10^{-4}	10^{-11}	10^{-4}	5×10^{-12}
		GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
	(Insol)	**Lung**			10^{-10}		4×10^{-11}
		GI (LLI)		8×10^{-4}	10^{-7}	3×10^{-4}	5×10^{-8}

TABLE 1. *Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure*—Continued

Radionuclide and type of decay	Organ of reference (critical organ in boldface)	Maximum permissible burden in total body $q(\mu c)$	Maximum permissible concentrations			
			For 40 hour week		For 168 hour week	
			$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$	$(MPC)_w$ $\mu c/cc$	$(MPC)_a$ $\mu c/cc$
$_{96}Cm^{246}$ (α)						
(Sol)	**Bone**	0.05	$\mathbf{10^{-4}}$	$\mathbf{5\times10^{-12}}$	$\mathbf{4\times10^{-5}}$	$\mathbf{2\times10^{-12}}$
	Liver	0.5	2×10^{-4}	8×10^{-12}	7×10^{-5}	3×10^{-12}
	Kidney	0.2	2×10^{-4}	9×10^{-12}	7×10^{-5}	3×10^{-12}
	Total Body	0.4	3×10^{-4}	10^{-11}	10^{-4}	5×10^{-12}
	GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
(Insol)	**Lung**			$\mathbf{10^{-10}}$		$\mathbf{4\times10^{-11}}$
	GI (LLI)		$\mathbf{8\times10^{-4}}$	10^{-7}	$\mathbf{3\times10^{-4}}$	5×10^{-8}
$_{97}Bk^{249}$ $(\alpha, \beta^-, \gamma)$						
(Sol)	**GI (LLI)**		**0.02**	4×10^{-6}	$\mathbf{6\times10^{-3}}$	10^{-6}
	Bone	0.7	0.07	$\mathbf{9\times10^{-10}}$	0.02	$\mathbf{3\times10^{-10}}$
	Total Body	5	0.5	7×10^{-9}	0.2	2×10^{-9}
(Insol)	**Lung**			$\mathbf{10^{-7}}$		$\mathbf{4\times10^{-8}}$
	GI (LLI)		**0.02**	3×10^{-6}	$\mathbf{6\times10^{-3}}$	10^{-6}
$_{98}Cf^{249}(\alpha, \gamma)$						
(Sol)	**Bone**	0.04	$\mathbf{10^{-4}}$	$\mathbf{2\times10^{-12}}$	$\mathbf{4\times10^{-5}}$	$\mathbf{5\times10^{-13}}$
	GI (LLI)		7×10^{-4}	2×10^{-7}	2×10^{-4}	5×10^{-8}
	Total Body	0.3	9×10^{-4}	10^{-11}	3×10^{-4}	4×10^{-12}
(Insol)	**Lung**			$\mathbf{10^{-10}}$		$\mathbf{3\times10^{-11}}$
	GI (LLI)		$\mathbf{7\times10^{-4}}$	10^{-7}	$\mathbf{2\times10^{-4}}$	4×10^{-8}

$_{98}Cf^{250}(\alpha)$	(Sol)	**Bone**	0.04	4×10^{-4}	5×10^{-12}	10^{-4}	2×10^{-12}
		GI (LLI)		7×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Total Body	0.3	3×10^{-3}	4×10^{-11}	10^{-3}	10^{-11}
	(Insol)	**Lung**			10^{-10}		3×10^{-11}
		GI (LLI)		7×10^{-4}	10^{-7}	3×10^{-4}	4×10^{-8}
$_{98}Cf^{252}(\alpha, \gamma)$	(Sol)	**GI (LLI)**		7×10^{-4}	2×10^{-7}	2×10^{-4}	5×10^{-8}
		Bone	0.04	2×10^{-3}	2×10^{-11}	6×10^{-4}	7×10^{-12}
		Total Body	0.3	0.01	2×10^{-10}	4×10^{-3}	5×10^{-11}
	(Insol)	**Lung**			10^{-10}		4×10^{-11}
		GI (LLI)		7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}

In keeping with its previous practice [3] when recommending changes in MPD levels, the NCRP suggests that a 5-year transition period be allowed during which the new values in Table 1 may be put into effect.

TABLE 2.—*Radionuclides which do not reach equilibrium in the body within 50 years*

Z	Radionuclide	Radioactive half-life T_r (yr)	Biological half-life T_b (yr)	Effective half-life T (yr)	Percent equil. reached in 50 yr
38	Sr^{90}	28	50	18	86
88	Ra^{226}	1622	45	44	56
89	Ac^{227}	21. 8	200	20	83
90	Th^{230}	8.0×10^{4}	200	200	16
90	Th^{232}	1.39×10^{10}	200	200	16
91	Pa^{231}	3.4×10^{4}	200	200	16
93	Np^{237}	2.20×10^{6}	200	200	16
94	Pu^{238}	89. 6	200	62	43
94	Pu^{239}	2.44×10^{4}	200	200	16
94	Pu^{240}	6.6×10^{3}	200	190	16
94	Pu^{241}	13. 2	200	12	94
94	Pu^{242}	3.8×10^{5}	200	200	16
95	Am^{241}	462	200	140	22
95	Am^{243}	8×10^{3}	200	200	16
96	Cm^{243}	35	200	30	69
96	Cm^{244}	18. 4	200	17	87
96	Cm^{245}	2×10^{4}	200	200	16
96	Cm^{246}	6.6×10^{3}	200	190	16
98	Cf^{249}	4.7×10^{2}	200	140	22
98	Cf^{250}	10	200	10	97

TABLE 3. *Provisional maximum permissible concentration of unidentified radionuclides in water* $(MPCU)_w$

Values that are applicable for occupational exposure (168 hr/wk) to any radionuclide or mixture of radionuclides

Limitations	μc/cc of water**
If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226} Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present* the continuous exposure level $(MPC)_w$, is not less than	3×10^{-5}
If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, Ra^{223}, Ra^{226}, Ra^{228}, Pa^{231}, and Th-nat are not present* the continuous exposure level $(MPC)_w$, is not less than	2×10^{-5}
If Sr^{90}, Pb^{210}, Ra^{226}, and Ra^{228} are not present* the continuous exposure level $(MPC)_w$, is not less than	6×10^{-6}
If Ra^{226} and Ra^{228} are not present* the continuous exposure level $(MPC)_w$, is not less than	10^{-6}
In all cases the continuous occupational level $(MPC)_w$, is not less than	10^{-7}

*In this case "not present" implies the concentration of the radionuclide in water is small compared with the MPC value in table 1.
**Use 1/10 of these values for interim application in the neighborhood of an atomic energy plant.

TABLE 4. *Provisional maximum permissible concentration of unidentified radionuclides in air* $(MPCU)_a$

Values that are applicable for occupational exposure (168 hr/wk) to any radionuclide or mixture of radionuclides

Limitations	μc/cc of air**
If there are no α-emitters and if β-emitters Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, and Bk^{249} are not present* the continuous exposure level, $(MPC)_a$, is not less than	10^{-9}
If there are no α-emitters and if β-emitters Pb^{210}, Ac^{227}, Ra^{228}, and Pu^{241} are not present* the continuous exposure level, $(MPC)_a$, is not less than	10^{-10}
If there are no α-emitters and if β-emitter Ac^{227} is not present* the continuous exposure level, $(MPC)_a$, is not less than	10^{-11}
If Ac^{227}, Th^{230}, Pa^{231}, Th^{232}, Th-nat, Pu^{238}, Pu^{239}, Pu^{240}, Pu^{242}, and Cf^{249} are not present* the continuous exposure level, $(MPC)_a$, is not less than	10^{-12}
If Pa^{231}, Th-nat, Pu^{239}, Pu^{240}, Pu^{242}, and Cf^{249} are not present* the continuous exposure level, $(MPC)_a$, is not less than	7×10^{-13}
In all cases the continuous occupational level, $(MPC)_a$, is not less than	4×10^{-13}

*In this case "not present" implies the concentration of the radionuclide in air is small compared with the MPC value in table 1.
**Use 1/10 of these values for interim application in the neighborhood of an atomic energy plant.

TABLE 5. *Calculation of MPC of a mixture of radionuclides*

Sample of concurrent exposure to several radionuclides (in soluble form) and an external source of radiation

Source of exposure	Body organ exposed	In air*	In water*
Sr^{90}	Bone	$\frac{\rho_{aA}}{(MPC)^{x}_{aA}} = \frac{1.8\times10^{-11}\mu c/cc}{3\times10^{-10}\mu c/cc}$	$\frac{\rho_{wA}}{(MPC)^{x}_{wA}} = \frac{1.5\times10^{-7}\mu c/cc}{4\times10^{-6}\mu c/cc}$
	Total body	$\frac{\rho_{aA}}{(MPC)^{TB}_{aA}} = \frac{1.8\times10^{-11}\mu c/cc}{9\times10^{-10}\mu c/cc}$	$\frac{\rho_{wA}}{(MPC)^{TB}_{wA}} = \frac{1.5\times10^{-7}\mu c/cc}{1\times10^{-5}\mu c/cc}$
Pu^{239}	Bone	$\frac{\rho_{aB}}{(MPC)^{x}_{aB}} = \frac{4\times10^{-13}\mu c/cc}{2\times10^{-12}\mu c/cc}$	$\frac{\rho_{wB}}{(MPC)^{x}_{wB}} = \frac{1.3\times10^{-5}\mu c/cc}{1\times10^{-4}\mu c/cc}$
	Total body	$\frac{\rho_{aB}}{(MPC)^{TB}_{aB}} = \frac{4\times10^{-13}\mu c/cc}{1\times10^{-11}\mu c/cc}$	$\frac{\rho_{wB}}{(MPC)^{TB}_{wB}} = \frac{1.3\times10^{-5}\mu c/cc}{1\times10^{-3}\mu c/cc}$
Na^{24}	Total body	$\frac{\rho_{aC}}{(MPC)^{TB}_{aC}} = \frac{2\times10^{-7}\mu c/cc}{2\times10^{-6}\mu c/cc}$	$\frac{\rho_{wC}}{(MPC)^{TB}_{wC}} = \frac{2\times10^{-3}\mu c/cc}{1\times10^{-2}\mu c/cc}$
γ**	Bone	$\frac{R^{x}_{\gamma}}{L^{x}} = \frac{0.065 \text{ rem/week}}{0.56 \text{ rem/week}}$	
	Total body	$\frac{R^{TB}_{\gamma}}{L^{TB}} = \frac{0.065 \text{ rem/week}}{0.1 \text{ rem/week}}$	

* The ratios given for Sr^{90}, Pu^{239}, and Na^{24} are the (μc/cc present in air)/$(MPC)^{x}_{aA}$ where $(MPC)^{x}_{aA}$ is the $(MPC)_a$ for element $A(Sr^{90})$and organ x (bone), etc.

** The ratio given for γ is the (actual RBE dose rate)/(maximum permissible RBE dose rate).

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